MAY
1951

Chemical Engineering

POLLUTION CONTROL REPORT TAKES UP BOTH WATER AND AIR POLLUTION **PAGE 111**

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MAY
1951

Chemical Engineering

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ENGINEERING AND EQUIPMENT

Pollution Control 111

A 48-page Feature Report Contributed by: Anthony Anable, E. B. Besselievre, K. A. Bownes, H. L. Jacobs, Gordon Kiddoo, C. E. Lapple, F. W. Mohlman, Melvin Nord, Leslie Silverman, Marcus Sittenfield, W. T. Sproull, Amos Turk, W. O. Vedder. Complete contents, p. 113.

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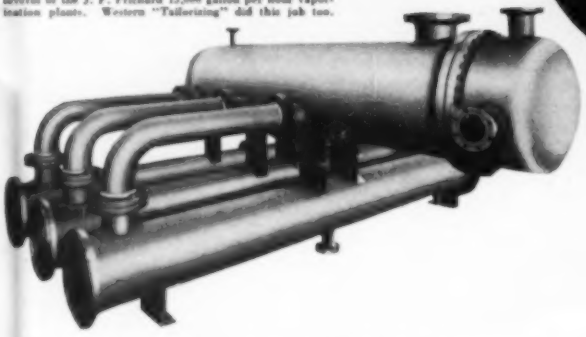

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What are your heat exchanger needs? Is your problem a replacement or an entirely new heat transfer installation? Regardless of the situation you face WESTERN has the *answer* in "TAILORIZING". Tailorizing simply means doing the job the way you want it done—fitting design . . . fabrication . . . and installation to the particular set of specifications peculiar to your plant, your operation. So you see—"Tailorizing" just means COMMON SENSE. But that common sense pays off for you—pays off in service and durability, and that means it pays off in good hard cash. Check your operational and maintenance records now . . . look over your heat transfer equipment with an eye on the future. Whether it's shell and tube exchangers . . . reboilers . . . atmospheric sections, the WESTERN technical staff will gladly consult with you on ALL your heat exchanger needs. Complete reports on our facilities and operational methods are available upon your request. We solicit your inquiries.

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Resins—for impregnated fabrics, linoleum, and adhesives.
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0.8427 Specific Gravity at 20/20°C. 0.8474
52.6°C. Boiling Point at 760 mm. Hg 68.0°C.
215 mm. Vapor Pressure at 20°C. 120 mm.
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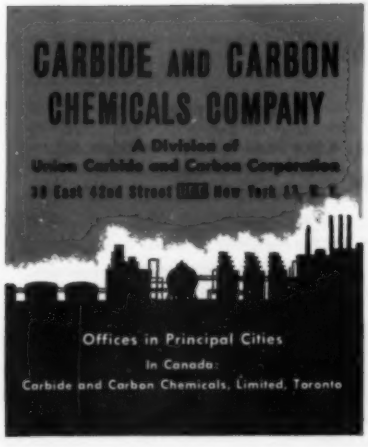
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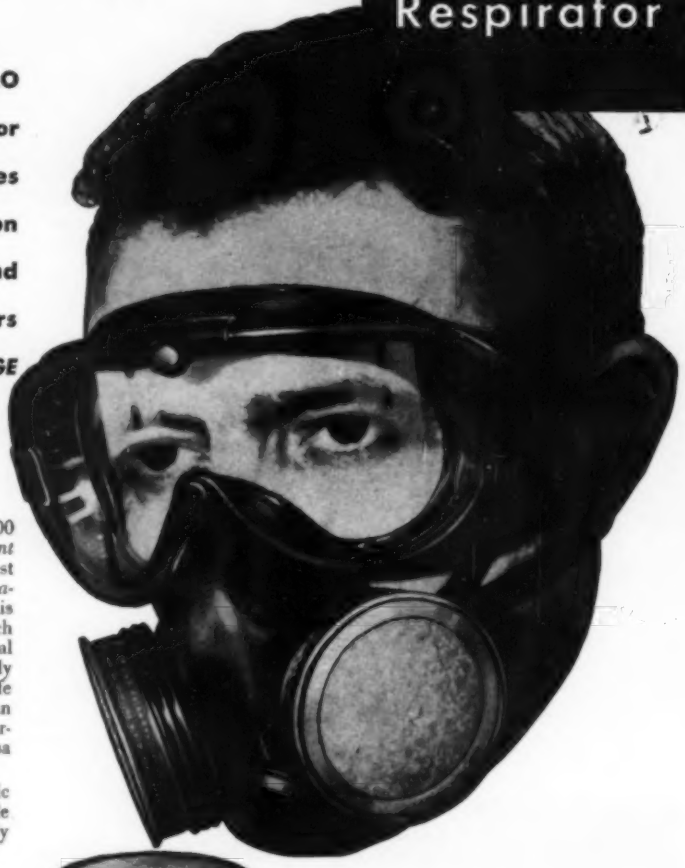

Yes, the AO R5055 Respirator (R5000 line) leads the way to a new, *convenient* standard of safety by protecting against organic vapors and all dusts *simultaneously*. The "business end" of this protection is the R55 cartridge which contains *both* a highly efficient chemical absorbent and a cover of chemically treated felt. Result: wearers are safe when both hazards are present and can move freely from dust to organic vapor-contaminated atmospheres or vice versa without changing cartridges.

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(2) Light organic fumes, vapors and gases
(3) Acid gases, fumes and mists
(4) Combined acid and organic gases
(5) Low concentrations of ammonia
(6) Metal fumes as in welding, burning, smelting, refining

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- Double headband

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Gunthard BUILDS HOMOGENEOUS LEAD-LINED EQUIPMENT.....

TO YOUR Specifications

This vessel, a 12' x 18' homogeneous lead-lined agitator, is one of several fabricated and installed for one of the largest petroleum refineries on the Gulf Coast.

Homogeneous lead-lined equipment by Gunthard, specified here in order to eliminate breakdowns and thus reduce costly shut-down time to a minimum quickly resulted in

- SAVINGS IN MAN HOURS
- SAVINGS IN OVERALL OPERATING COSTS

in excess of the original cost of the vessel.

The Gunthard organization has every facility for fabricating homogeneous lead-lined equipment—from 2 inch carbon steel fittings and all sizes of tanks and vessels, up to massive 90 foot towers. Skilled personnel fabricate equipment of every type from ferrous and non-ferrous metals including aluminum, stainless, stainless-clad and carbon steels.

We number among our regular customers many of the largest and most progressive chemical processing companies in the nation. If you have a problem that might be solved by expert metal fabrication—with or without lead lining or covering—write for complete information on how Gunthard engineering services and facilities can be of provable cost-cutting value to you.

A. GUNTHARD COMPANY ENNIS, TEXAS

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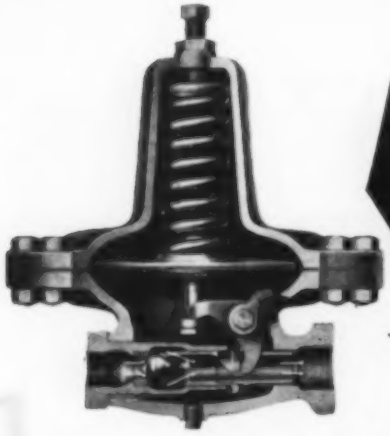
CASH STANDARD *Streamlined* TYPE 1000 PRESSURE **REDUCING VALVES**

THESE TROUBLEMAKERS FIND NO OPPORTUNITY TO PERFORM WITH THE "1000" ON THE JOB



A MANUFACTURER CHECKS THE 10 POINTS AND SAYS . . .

"We have 3 of these '1000' valves and all of them are giving good service."

THE 10 POINTS ARE CHECKED BY A RESEARCH FOUNDATION, THEY SAY

"These valves have been VERY SATISFACTORY BOTH IN OPERATION and MAINTENANCE. The MAINTENANCE COST IS ABSOLUTELY NOTHING once this '1000' valve is installed. Wherever any one may need CONTROLLED PRESSURE IN EITHER STEAM, AIR, or ANYTHING—this CASH STANDARD '1000' valve can be relied upon to do just that and TO GIVE CONTINUED TROUBLE-FREE service."

A MEAT PACKER SAYS IN CHECKING THE 10 POINTS . . .

"Very little maintenance required."

A STEEL CASTING CO. CHECKS THE 10 POINTS—THEY SAY . . .

"We find your CASH STANDARD Streamlined Type '1000' Pressure Reducing Valves to be VERY RELIABLE. We have a number of these valves in service throughout our plant, and have NEVER HAD ONE OUT OF SERVICE for any reason. These '1000' valves have been in service for approximately five years."

A MOULDED PRODUCTS CO. CHECKS THE 10 POINTS AND SAYS

"Maintenance time and cost very low."

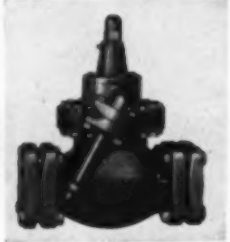
These are the Points
USERS CHECK WITH . . .

1. **Maximum capacity when needed most.**
2. **Accurate pressure control under toughest working conditions.**
3. **Trouble-free service.**
4. **Smooth operation.**
5. **Tight closure.**
6. **Speedier production results.**
7. **Elimination of failures.**
8. **Cost-saving operation.**
9. **No spoilage.**
10. **Practically zero in maintenance.**

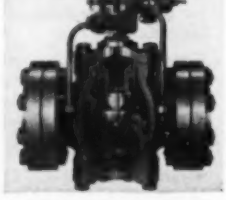
→ ***WRITE FOR BULLETIN 962***

BULLETINS AVAILABLE ON OTHER CASH STANDARD VALVES
Send for them

Bulletin 950—features the CASH STANDARD Type D Single Seat Pressure Reducing and Regulating Valves for use with most fluids. Shows simple inner working parts that save in maintenance. Diagram explains how valve works. Blueprint shows simplicity of installation.



Bulletin 956—features the CASH STANDARD Type 4030 Back Pressure Valve — designed to automatically maintain a constant pressure in the evaporator corresponding to a constant temperature desired. Shows an Ammonia and Freon Gas Capacity Chart based on ABSOLUTE pressures.



Bulletin 966—features the CASH STANDARD Self-Contained, Pilot Operated Type 10 Pressure Reducing and Regulating Valve for use with water or air; with any gas or oil that is non-corrosive; and with refrigerating fluids such as Ammonia and Freon. Many interesting particulars explained such as: how valve works, tight seating, large capacity, no waste, no water hammer or chatter.

CASH STANDARD CONTROLS.. VALVES

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3. Variations in feed don't bother the BIRD. Slurries may contain from 10 to 40% solids. Occasional poor filtering slurries used to bog down the whole process. The BIRD Centrifugal Filter takes them in stride.

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BIRD MACHINE COMPANY

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. . . saves bending time, enables WESTERN BLOWER CO. to produce neater, more uniform tube bundles.

During the past nine years, Western Blower Co., of Seattle, Wash., has used hundreds of thousands of feet of ⅝" and 1" O.D. Revere Seamless Copper Tube of special bending temper, with .049" wall.

They tell us that in working with this Revere Tube they are able to make large and small radius bends without the slightest difficulty and without heat treating, excepting the smallest 1" radius. This not only saves bending time but, enables them to turn out a better appearing tube bundle . . . an important item with Western Blower as many of their bundles are sold without tanks.

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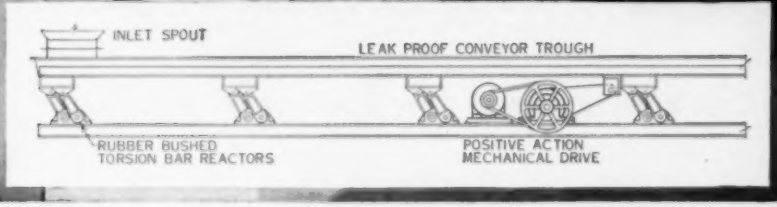

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CAPACITIES—Adapted to efficient, trouble-free conveying of a range of loads from pounds to tons per hour in standard trough widths from 6 to 48 inches and lengths up to 100 feet.

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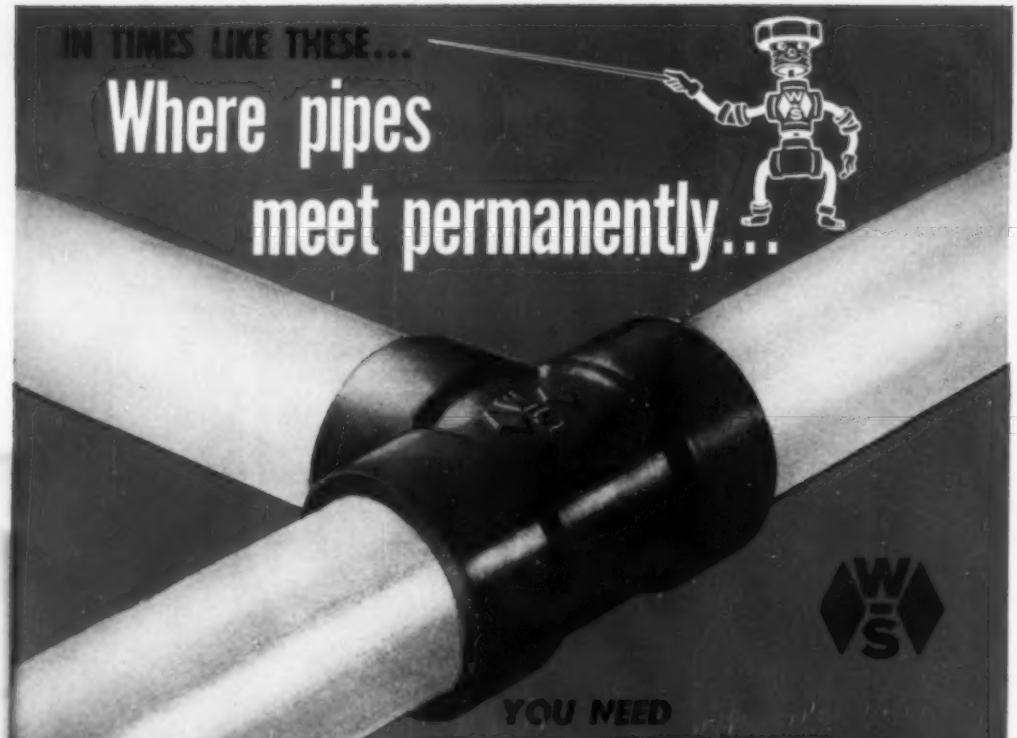
Where pipes meet permanently...



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SCREWED AND SOCKET-WELD FITTINGS

SCREWED FITTINGS . . . are designed with ample metal sections. The wall-thickness is faithfully observed in final manufacture. Extra long bands extend well beyond the last thread, providing reinforcement at points of severest strain. Threading — is long, accurately cut, and perfectly aligned to insure tight joints. All fittings are properly chamfered to protect thread and afford easy entrance of the pipe.

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Four types

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OFFER A WIDE SELECTION TO SOLVE ANY COOLING PROBLEM

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This type cooler is widely favored because of its great efficiency. The diaphragm section is constructed to allow for expansion or contraction without distortion. Equal distribution of load in this type cooler reduces power requirements to a minimum.

A straight flow unit, designed for processes where the product size of the material is so fine that the cooling air will carry it back into the calcining unit. This type cooler also provides careful dust control at the discharge end.

Also a straight flow unit. The tubes which carry the material are cooled by a continuous cold water spray. This type cooler offers the same operating advantages as the air-cooled multiple tube cooler. For certain processes a combination of both air and water cooling is found to be most efficient.

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With soda ash, caustic and other chemicals so much in demand, we think it would be a good idea to have your specifications on file with us . . . even if you aren't a present customer of ours.

We may be able to be of service. Take the way our Technical Service Department helped a large rayon producer. This company had been buying caustic soda from many producers . . . with no definite specifications. They asked our help and our Technical Service Department — after a series of conferences — set up tentative specifications.

We now supply them with a detailed analysis, including spectrographic, of each shipment. And with a monthly summary sent to all departments concerned. We think that's the way to do business. And if the opportunity to serve you arises, we think you will agree.

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CALCIUM CARBONATE • CALCIUM CHLORIDE • CHLORINE
HYDROGEN • DRY ICE • SYNTHETIC DETERGENTS • GLYCOLS
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Lasts longer in corrosive service

This acid-shield ALOYCO gate valve is made in a wide range of analyses to specification, and is regularly stocked in popular alloys.

Like all ALOYCO valves, its dependable performance results from:

A. Metallurgical research devoted *exclusively* to corrosive applications;

B. foundry and machine shop facilities set up for *only* high alloys;

C. casting and machining practices dictated by the difficult characteristics of the alloys required for corrosive services.

Success Stories from ALOYCO's Corrosion Clinic

THE CORROSIVE: fatty acids.

THE PLACE: E. F. Drew & Company, Inc., Boonton, N. J.

THE INSTALLATION: Multiple steps in production of high-purity distilled and fractionated fatty acids—operating on vacuum service of 5-6 mm to 25 psi and temperatures of 125-500 F.

THE VALVE: ALOYCO 363 "Y" valve, 2 in. size, in alloy type 316 (18-8SMo).

Orifice-type test rods exposed in customers' pipeline are studied to determine proper specification of valve material.

THE BACKGROUND: The *Aloyco Corrosion Clinic* is a service to chemical process engineers who encounter problems of corrosive damage to valves.

Alloy Steel Products Company maintains the *largest* laboratory devoted *exclusively* to the "diagnosis" and "treatment" of problems relating to valves in corrosive service. From the results of laboratory and field testing, it develops the specifications for customers' applications.

Its success in lengthening valve life on corrosive services explains why *more* ALOYCO corrosion-resistant valves are used than any other brand.

If *your* plant deals with severe corrosives or must guard against product contamination or discoloration, put your problem before The *Aloyco Corrosion Clinic*.

ALLOY STEEL PRODUCTS CO., INC.
1305 West Elizabeth Avenue, Linden, N. J.

Longer Lasting
ALOYCO VALVES
1st in Corrosive Service

Looking for evaporator pumps?

Worthite pump handling distillery slop.

A battery of Worthites pumping black liquor in a soda pulp plant.

You can get the best in Worthington Worthite Centrifugal Pumps

By standardizing on a complete range of sizes in one superior stainless steel, Worthington can concentrate its volume and inventories. This means you can get the centrifugal pump and parts you need for handling corrosive liquids and other chemicals. Thousands of these Worthington *standard* pumps are now in evaporator service, pumping such widely varying liquids as black liquor, ammonium sulfate and frozen orange concentrate. Their advanced design and exceptional resistance to abrasion and corrosion assure best results at lowest operating cost.

FOR ALL EVAPORATOR SERVICES

Worthington has evolved a scientific method of selecting exactly the right pump for size, speed, head, capacity and NPSH. Let us show you how it works. For further facts proving *there's more worth in Worthington*, call your nearest District Office. Or write to *Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, N. J.*

TYPICAL LEADING MANUFACTURERS OF EVAPORATOR SYSTEMS USING WORTHITE PUMPS

Buflovak • General American Transportation
Gaslin Birmingham • Koppers
Majonnier Brothers • Struthers Wells
Swenson • Wilputte • Zaremba

WORTHINGTON

C1-1

THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB

Types CB and CBL. Sizes ¾" to 10". Capacities to 3000 GPM; heads to 200 ft. Liquid ends of WORTHITE alloy.

Type CP. Sizes 1" to 4". Capacities to 1000 GPM; heads to 130 ft. Standard, all iron and all bronze.

Type CQ. Sizes 1½" to 3". Capacities to 600 GPM; heads to 130 ft. at 1750 RPM. Closed impeller. WORTHITE shaft and fittings.

Type L. Sizes 3" to 8". Capacities to 2250 GPM; heads to 300 ft. Single stage volute. For general service.

Always comes clean!

Swan-Finch uses Tri-Sure Closures to keep impurities from its famous Motor Oils, Gear Oils and Hydraulic Oils

Almost a century ago, the Swan-Finch Oil Corporation was founded on a reputation for *quality* and *dependability*. Today that reputation attains its pinnacle in the Swan-Finch Line of Lubricating Oils and Greases.

Motul Motor Oils are noted for their high viscosity index and resistance to oxidation, because they embody selected base stocks . . . painstakingly refined—and additives.

Motul Motor Oils and Safco Industrial Oils are known for their *purity*, their complete freedom from contamination—because every Swan-Finch drum is protected by Tri-Sure Closures*.

Operators of hydraulic equipment, for instance, know that Saf-Drive Hydraulic Oils are *always clean*—will never clog the delicate parts of a pump—because they are delivered in drums that *seal out* all impurities.

Today, Tri-Sure protection is an additional selling feature for any drum delivered product. Utilize it now—to give *your* product security from leakage, contamination and undetected pilferage. When you order drums, just specify "Tri-Sure Closures".

**The "Tri-Sure" Trademark is a mark of reliability backed by 28 years serving industry. It tells your customers that genuine Tri-Sure Flanges (inserted with genuine Tri-Sure dies), Plugs and Seals have been used.*

Tri-Sure
Reg. U. S. Pat. Off.

CLOSURES

AMERICAN FLANGE & MANUFACTURING CO. INC., 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.
TRI-SURE PRODUCTS LIMITED, ST. CATHARINES, ONTARIO, CANADA

YOU ARE SAFE when your source of supply has

• SEVERAL APPROACHES TO EACH PROBLEM

• The Armament Program must inevitably produce dislocations and allocations. The field of Organic Chemicals will know its share.

In all of our divisions . . . of surfactants — textile, leather and paper chemicals – chemical intermediates and carbonyl iron powders . . . we are organized for full production, backed by tremendous research, warehousing and service facilities.

Out of long and extensive research, we can offer our customers many approaches to each of their chemical processing operations. This provides an important margin of safety — for you, as well as for us. Moreover, we invite you to make use of our highly specialized laboratories as an adjunct to your own.

We invite the opportunity to work with you – in the improvement of an existing product, the development of a new product or the establishment of a second or third line of defense against possible interruption of your materials supply. Your inquiry will bring a prompt response, involving no obligation.

ANTARA® PRODUCTS

DIVISION OF

GENERAL DYESTUFF CORPORATION

435 HUDSON STREET • NEW YORK 14, NEW YORK

BRANCHES

Boston • Providence • Philadelphia • Charlotte, N. C. • Chicago • Portland, Ore. • San Francisco

IN CANADA: Chemical Developments of Canada Limited, Leaside, Toronto 17

Looking for tubes with a better life/cost ratio? Ask the experts!

This month's report is on: **SILMO**

Offers good combination of high temperature strength and oxidation resistance. At 1000°F.—1150°F., it has about twice the strength of carbon steel and oxidation resistance comparable to 4-6 Cr. Mo. For use in cracking furnace, heater, high pressure boiler and superheater tubes.

ONE OF 23 TIMKEN HIGH TEMPERATURE STEELS

Carbon	Sicromo 2	Sicromo 5S	16-13-3
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	25-20
DM-2	2½% Cr.-1% Mo.	Sicromo 7	25-12
Silmo	Sicromo 3	Sicromo 9M	35-15*
DM	4-6% Cr.-Mo.	18-8 Stainless	16-25-6*
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	

*Not available as seamless tubing at the present time.

If your high temperature tubes either fail too soon or last longer than needed, they're costing you too much. Only *one* high temperature steel can give you the best life/cost ratio. It's the one that's tailor-made for your particular operating conditions.

To make sure you get the *right* steel, consult the recognized authorities in this field—the Timken Company metallurgists. Their recommendations are backed by 21 years of pioneering research and the widest field experience. They have 23 analyses to choose from. And uniform tube quality is assured by our complete control from melt shop through final inspection.

Let the Timken Company's "RSQ"—Research, Supply, Quality—solve *your* tube problems. Ask the experts! The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, O. Cable address: "TIMROSCO".

Photo shows metallographic laboratory at the Timken Company, where structural characteristics of high temperature steels are determined. The Timken Company was first to test high temperature steels, and still leads in that research today.

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing

Century

PROTECTED MOTORS

Let You Forget About Atmospheric Hazards

Shown here are four basic types of Century Protected Motors which are designed to resist the dangers of hazardous atmospheres. A properly selected Century motor—with the right protection—is the ideal combination for a long life of satisfactory performance.

1 **Open Protected**—Form J, general purpose motor—meets the needs for most installations where operating conditions are relatively clean and dry. The top half of the motor frame is closed to keep out falling solids or dripping liquids.

2 **Splash Proof Motor**—gives the necessary protection where plants must be washed down—keeps water out of the motor even when a hose is applied directly on the frame. It also provides protection against rain, snow, sleet and ice for outdoor installations.

3 **Totally Enclosed Fan Cooled Motor**—protects against dusts, mist or fog that might be detrimental to the vital parts of the motor. The inner frame protecting the motor is sealed to keep out harmful matter.

4 **Explosion Proof Motor**—protects against atmospheres charged with explosive dusts or gases. They carry Underwriters' label for specific kinds of hazards.

Century builds a complete line of alternating and direct current motors in a wide range of types and kinds—in sizes from 1/6 to 400 horsepower.

Specify Century motors for all your electric power needs.

Century Electric Company is celebrating its 50th year in the electrical industry.

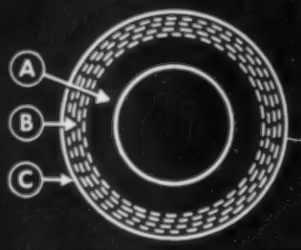
CE-632R

Century C MOTORS

CENTURY ELECTRIC COMPANY 1806 Pine Street • St. Louis 3, Missouri

Offices and Stock Points in Principal Cities

The Hose Acid Can't Harm



GOODYEAR INDUSTRIAL RUBBER PRODUCTS

G.T.M.-Specified STYLE M ACID-CONDUCTING HOSE for GENERAL CHEMICAL SERVICE

A – Tube of long-lived, acid-resistant stock; withstands temperatures up to 150° F. (See table below.)

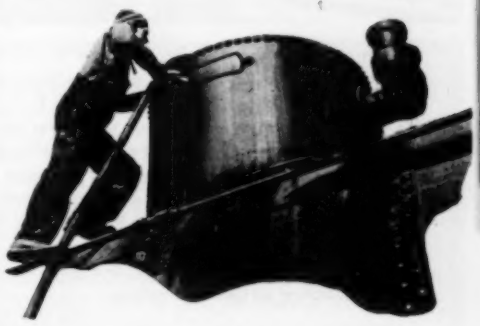
B – Fabric carcass, each ply frictioned with high-quality rubber firmly bonding tube to cover. Protected against chemical attack by heavy rubber cap at each end.

C – Cover of tough, abrasion-resistant black compound, proof against same chemicals as tube.

GOODYEAR STYLE M HOSE
Handles All These Chemicals

	Maximum Concentration	Maximum Temperature °F
ACIDS		
Arsenic	ALL	150
Acetic	50%	100
Carbonic	50%	150
Citric	ALL	150
Fluoboric	ALL	150
Fluosilicic	ALL	150
Formic	ALL	100
Hydrobromic	ALL	100
Hydrofluoric	ALL	100
Malic	ALL	150
Phosphoric	75%	150
Sulfuric	50%	125
Tannic	ALL	150
Tartaric	ALL	150
Hydrochloric	ALL	125
CANNOT HANDLE NITRIC ACID		
BASES		
Ammonium Hydroxide	50%	100
Calcium Hydroxide	ALL	150
Magnesium Hydroxide	ALL	150
Potassium Hydroxide	ALL	150
Sodium Hydroxide	ALL	150
SALTS		
Calcium Hypochlorite	ALL	150
Copper Sulphate	ALL	150
Ferric Chloride	ALL	150
Sodium Acid Sulphate	ALL	150
Sodium Carbonate	ALL	150
Sodium Chloride	ALL	150
Trisodium Phosphate	ALL	150
Sodium Sulphide	ALL	150
Sodium Sulphite	ALL	150

FOR HOSE, FLAT BELTS, V-BELTS, MOLDED GOODS, PACKING, TANK LINING, RUBBER-COVERED ROLLS built to the world's highest standard of quality, get in touch with the G.T.M.—Goodyear Technical Man—or phone your nearest Goodyear Industrial Rubber Products Distributor.



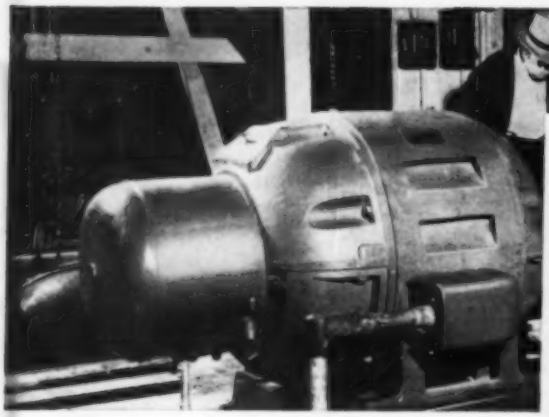
We think you'll like "THE GREATEST STORY EVER TOLD"—Every Sunday—ABC Network

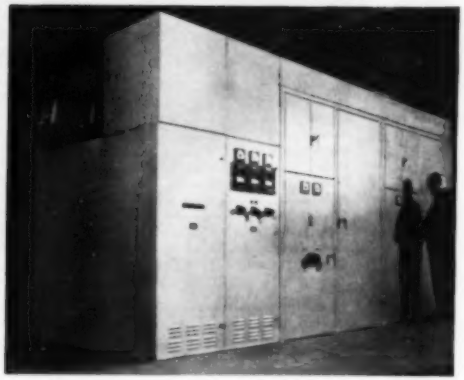
GOODYEAR

THE GREATEST NAME IN RUBBER

DEPENDABILITY where it counts

SYNCHRONOUS MOTORS

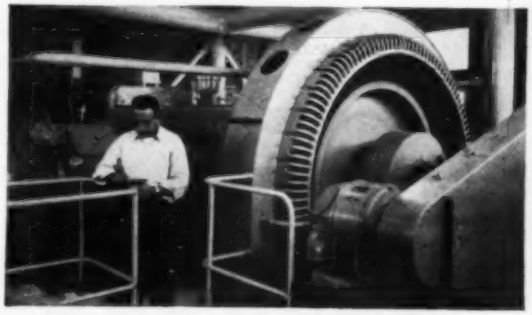




Dependability and long life are a must in water-pumping equipment. Cohoes, N. Y. selected a G-E Tri-Clad* 500-hp synchronous motor for their raw-water pumping station. And as protection against a short-circuit capacity of 60,000 kva, Cohoes selected G-E Limitamp high-voltage control. Besides providing accurate control for the motor, Limitamp clears shorts from the line in less than half a cycle—before damage can come to either motor or control. Ask your nearest G-E sales office for more information on Limitamp control.

* Reg. U. S. Pat. Off.

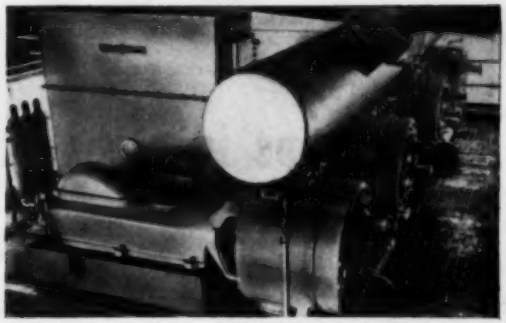
ON CRITICAL PUMPING OPERATIONS



Driving compressors in gas pumping station serving hundreds of homes, motor requirements were—dependability and low cost. This G-E 1500-hp synchronous motor scores on both counts.

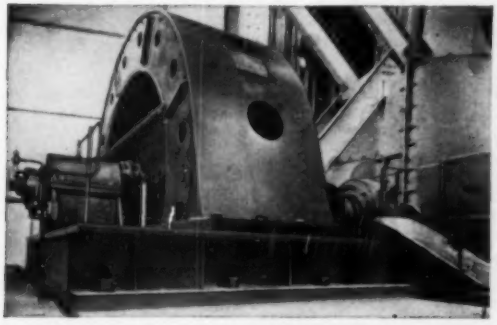
FOR SPECIAL SERVICE CONDITIONS

Corrosive, dust-laden atmosphere has no effect on this externally ventilated synchronous motor. Installed in a plastics mill, it's typical of the special enclosures that can be designed to meet almost any operating problem.

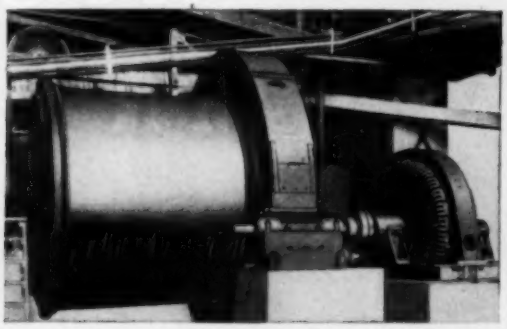


These gas compressors created a hazardous atmosphere for motor operation. The external enclosure of this 300-hp, G-E synchronous motor is filled with an inert gas to provide reliable operation.

FOR TOUGH JOBS



A motor must be rugged to drive a large wood chipper capable of chewing 40-inch diameter logs into small pieces. This G-E synchronous motor, with rigid, box-type construction will give years of dependable service—on a tough application.



To meet the rough test of driving a ball mill, this mining company chose a G-E high-torque synchronous motor rated at 600 hp. It's given them years of dependable operation and still going strong.

SAVE MONEY, TOO

It's a fact . . .

Lower Operating Costs,
higher operating efficiency.

Lower Initial Cost
including control and exciter—for many ratings.

Reduced Demand
and release of needed generating capacity.

Reduced Power Rates
for improved power factor.

Application engineers, with many years of field experience, will tailor G-E synchronous motors and control to your job. And, no matter where you are located, there's a G-E Service Shop near you.

For your next large, synchronous motor application, call in your General Electric representative—he'll be glad to discuss with you, your particular application. For more information on G-E synchronous motors, write for GEA-5332 (low-speed) or GEA-5426 (High-speed) to: *Section 770-24, General Electric Company, Schenectady 5, New York.*

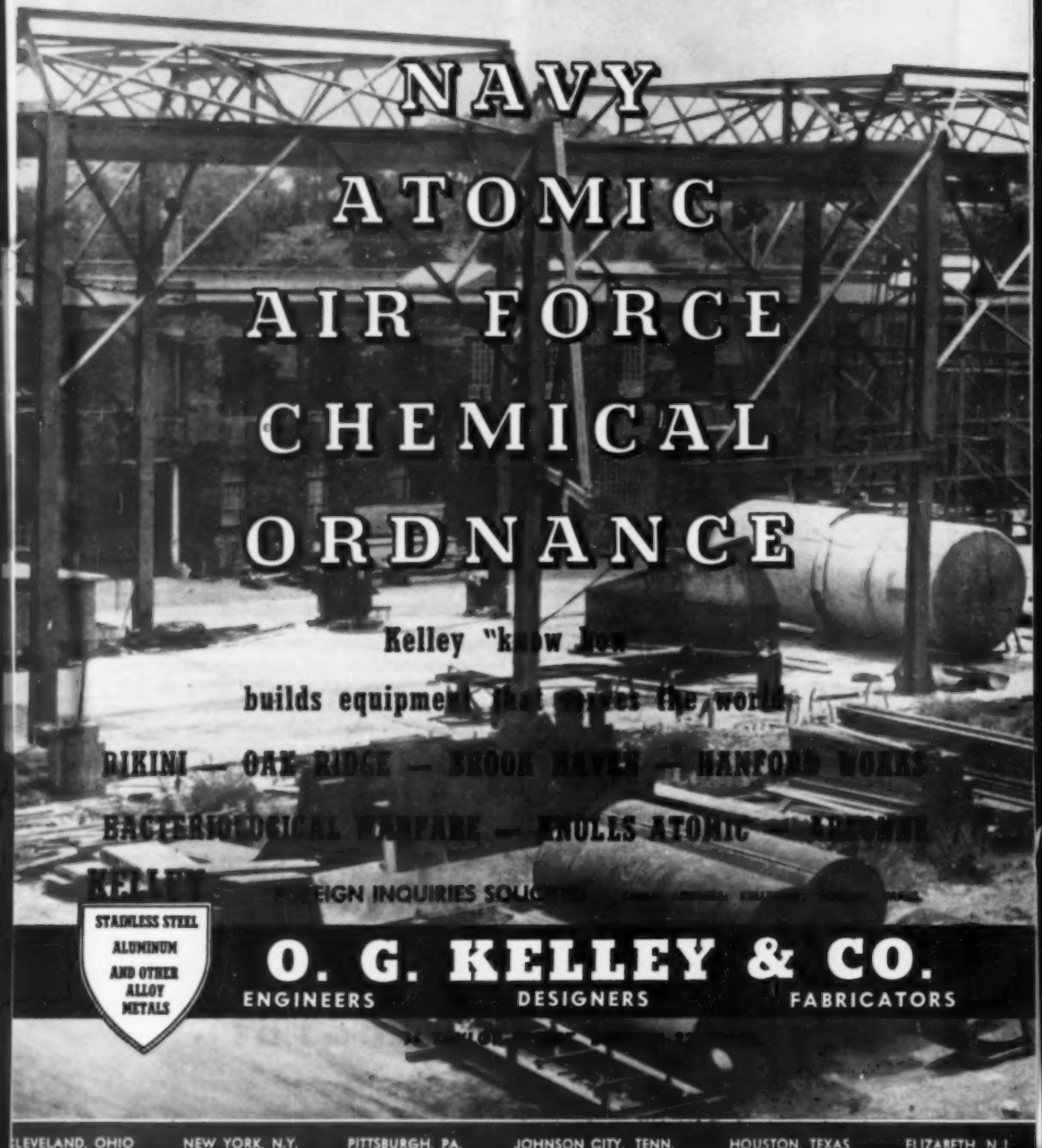
You can put your confidence in—

GENERAL ELECTRIC

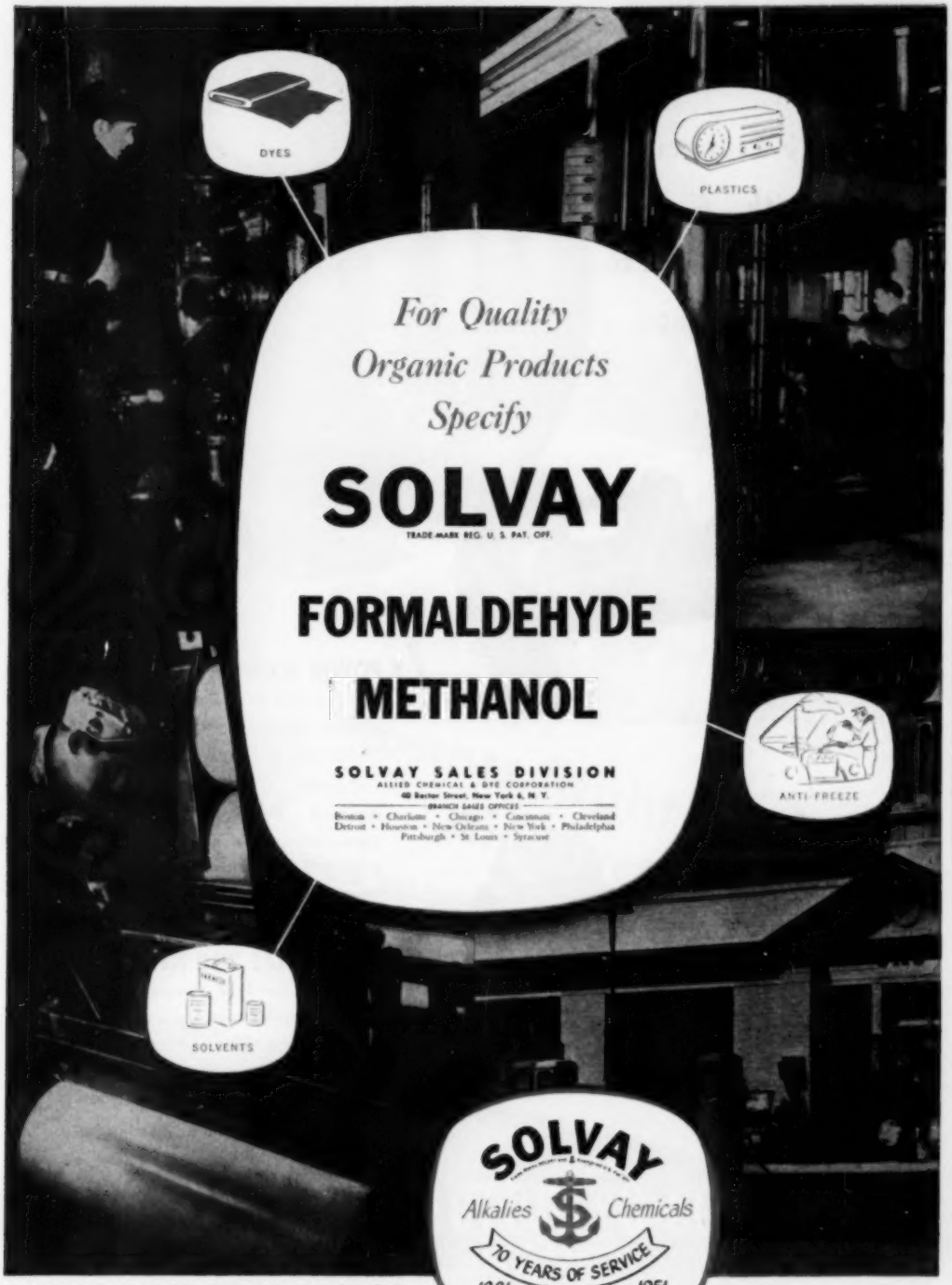
770-24

O. G. KELLEY & CO.

Keeps in step with all emergencies

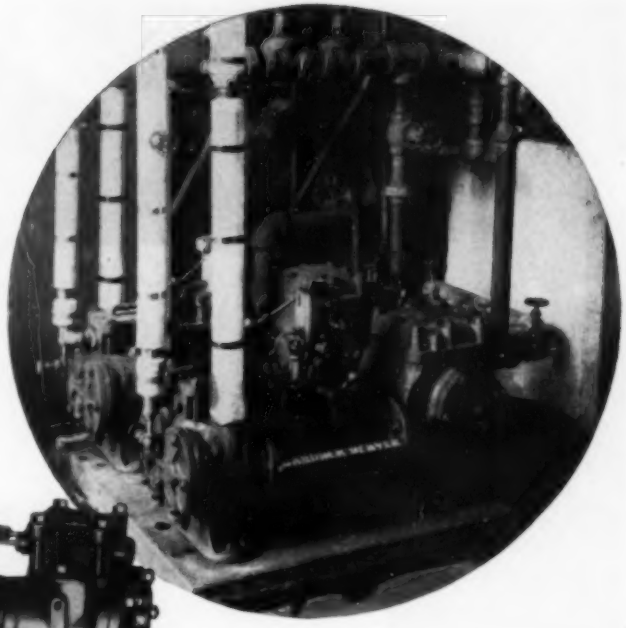


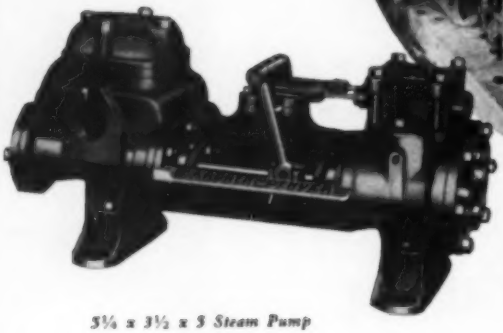
CLEVELAND, OHIO NEW YORK, N.Y. PITTSBURGH, PA. JOHNSON CITY, TENN. HOUSTON, TEXAS ELIZABETH, N.J.



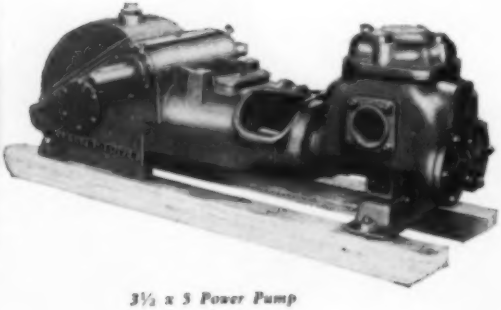
Soda Ash • Caustic Soda • Caustic Potash • Chlorine • Potassium Carbonate • Nylon • Calcium Chloride
Sodium Bicarbonate • Ammonium Bicarbonate • Specialty Cleansers • Methanol • Para-dichlorobenzene
Ortho-dichlorobenzene • Monochlorobenzene • Ammonium Chloride • Formaldehyde • Sodium Nitrite

2-Way Economy with GARDNER-DENVER Boiler Feed Pumps





5¼ x 3½ x 5 Steam Pump



3½ x 5 Power Pump

1. POWER ECONOMY! Gardner-Denver Steam Pumps have short and direct steam ports for greatest steam economy. The steam valves stay tight at all steam pressures.

Gardner-Denver Power Pumps are equipped with friction-defying Timken tapered roller main bearings. Herringbone gears and large eccentric bearings transmit more of the power into useful pumping.

2. IN THE SIZE YOU NEED! Gardner-Denver Boiler Feed Pumps are manufactured in a wide range of sizes, for any type of drive. Our pumping experts will gladly help you select just the right combination for maximum economy in your plant.

Write us today for further information.

SINCE 1859

GARDNER-DENVER

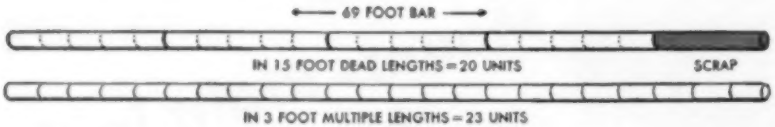
Gardner-Denver Company, Quincy, Illinois
In Canada:
Gardner-Denver Company (Canada), Ltd., Toronto, Ontario

THE QUALITY LEADER IN COMPRESSORS, PUMPS AND ROCK DRILLS

The JOY AXIVANE® FAN
Mounts Right in the Air Duct—
Saves space, installation costs, gives you quieter, more efficient ventilation!
A JOY Axivane Fan in a commercial store—chosen for its low noise level, compactness, and simple and easy installation.
Write for Bulletins, or
Consult a Joy Engineer
JOY MANUFACTURING COMPANY
GENERAL OFFICES: HENRY W. OLIVER BUILDING · PITTSBURGH 22, PA.
IN CANADA: JOY MANUFACTURING COMPANY (CANADA) LIMITED, GALT, ONTARIO

What you can do to make the supply of Stainless Steel go further

Minimize scrap losses at the mill by ordering the exact sizes that you will use



When you order sheets, plates or bars of Stainless Steel, don't confine your specifications to mere "dead lengths." Such procedure often leads to a waste of material.

Instead, place your orders in terms of *multiple lengths*. In other words, tell your supplier the actual dimension in which you will eventually use the steel. By doing this, you'll often get *extra* units from good steel that otherwise would be consigned to scrap.

For example, suppose you've been ordering 15-foot bars and are using the steel in 3-foot units. If the mill should roll a 69-foot bar, we could cut only four lengths or 20 3-foot units from it. But when ordered in multiple lengths, we could cut 23 units from the same bar, and scrap losses would be minimized.

The same thing holds true when you are ordering sheets, strip, or plates. The more we know how you will use the steel—the actual sizes you are planning to work to—the more chance we have of taking care of your requirements.

Cooperation from all concerned will stretch supplies of Stainless as far as possible. Specifying multiple lengths is one way you can help. (And it's equally important in your orders for alloy steels and plain carbon steels, too.)

Keep these points in mind, too, when you order Stainless.

Tell your supplier exactly where you'll use Stainless and how you'll fabricate it.

Indicate, if possible, acceptable alternates in composition, gage and finish.

AMERICAN STEEL & WIRE COMPANY, CLEVELAND · COLUMBIA STEEL COMPANY, SAN FRANCISCO
NATIONAL TUBE COMPANY, PITTSBURGH · TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM · UNITED STATES STEEL COMPANY, PITTSBURGH
UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

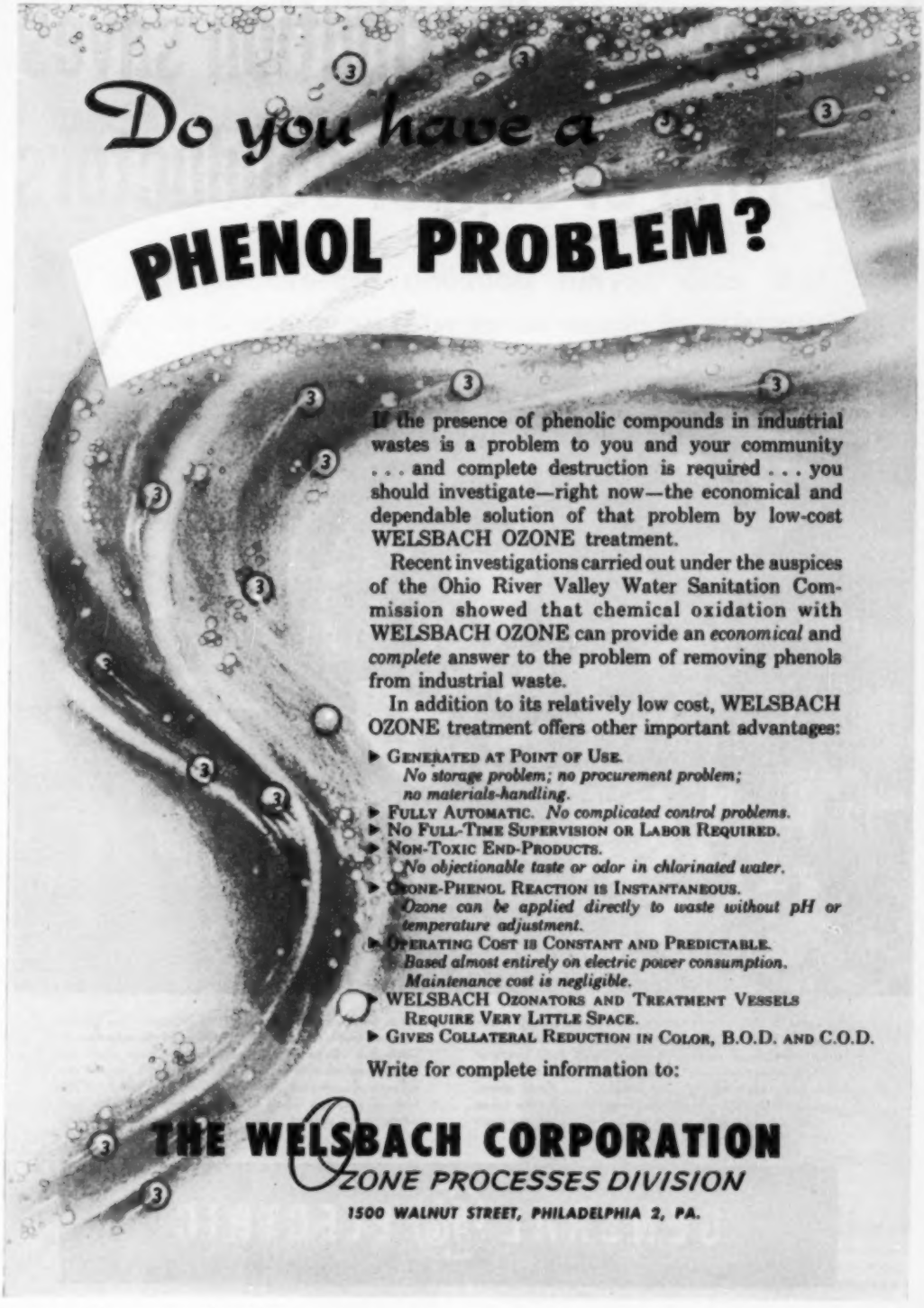
USS

U·S·S STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

1-580

UNITED STATES STEEL



If the presence of phenolic compounds in industrial wastes is a problem to you and your community . . . and complete destruction is required . . . you should investigate—right now—the economical and dependable solution of that problem by low-cost WELSBACH OZONE treatment.

Recent investigations carried out under the auspices of the Ohio River Valley Water Sanitation Commission showed that chemical oxidation with WELSBACH OZONE can provide an *economical* and *complete* answer to the problem of removing phenols from industrial waste.

In addition to its relatively low cost, WELSBACH OZONE treatment offers other important advantages:

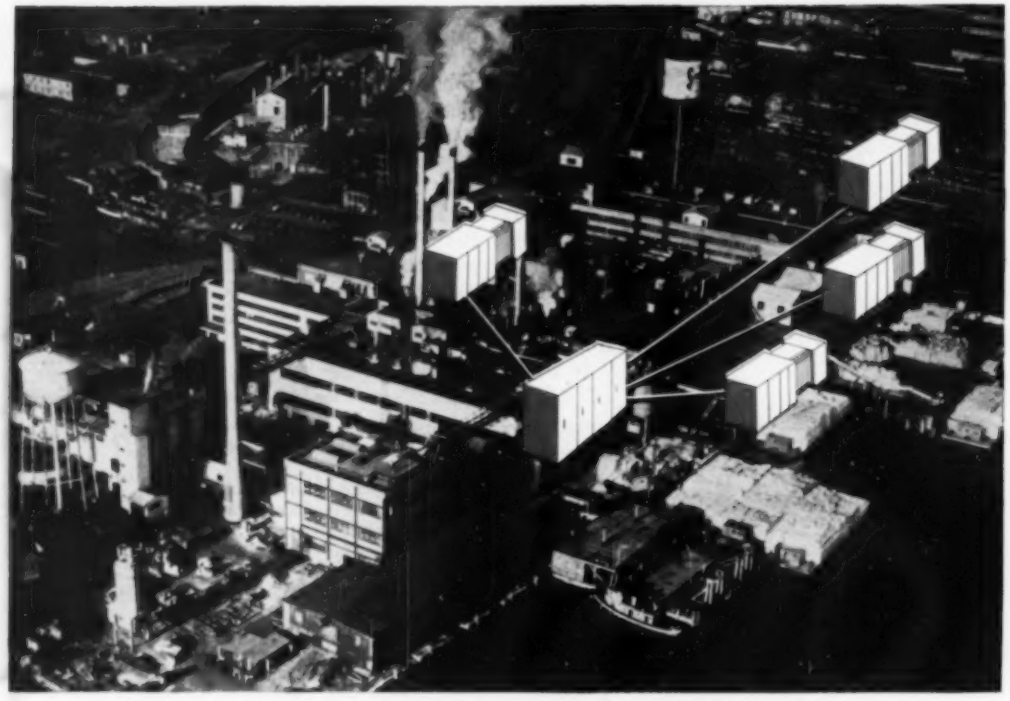
- GENERATED AT POINT OF USE.
  No storage problem; no procurement problem; no materials-handling.
- FULLY AUTOMATIC. *No complicated control problems.*
- NO FULL-TIME SUPERVISION OR LABOR REQUIRED.
- NON-TOXIC END-PRODUCTS.
  No objectionable taste or odor in chlorinated water.
- OZONE-PHENOL REACTION IS INSTANTANEOUS.
  Ozone can be applied directly to waste without pH or temperature adjustment.
- OPERATING COST IS CONSTANT AND PREDICTABLE.
  Based almost entirely on electric power consumption. Maintenance cost is negligible.
- WELSBACH OZONATORS AND TREATMENT VESSELS REQUIRE VERY LITTLE SPACE.
- GIVES COLLATERAL REDUCTION IN COLOR, B.O.D. AND C.O.D.

Write for complete information to:

THE WELSBACH CORPORATION
OZONE PROCESSES DIVISION
1500 WALNUT STREET, PHILADELPHIA 2, PA.

Load-center distribution saves 172 tons of copper conductors

Will also permit *doubling* present electrical capacity of paper plant with no major changes



All power formerly went through a main switchboard at the company's power station, and then to various buildings over large, low-voltage cables in 8-inch conduits. Total length of the low-voltage runs was about 4400 feet. This system has now been replaced by load centers, as shown above. Approximately 172 tons of copper conductors were saved.

Vital floor space has been gained by locating the load-center units on roofs of the various buildings served. Voltage has been improved, as has the flexibility of the entire power distribution system. Finally, provision has been made for further expansion wherever required. Actually, foundations for several additional load-center units were put in at the time—and in some cases, all that is needed to provide more power is to convert single-ended to double-ended units.

321-71

GENERAL ELECTRIC

Two load centers on the roof of one building serve one of the paper machines. Double-ended unit in background steps 13,200 volts down to 2300. Single-ended unit in foreground steps the high voltage down to 575. Addition of a transformer and airswitch to this low-voltage unit will double its capacity. Space is available to install a second unit if needed.

Scott Paper Company of Chester, Penna,. was distributing something over 10,000 kw of power throughout its plant at 575 volts.

An expansion program at the company raised power demands. It became necessary to increase, considerably, the tonnage of low-voltage cable in service—or to change the power-distribution system completely.

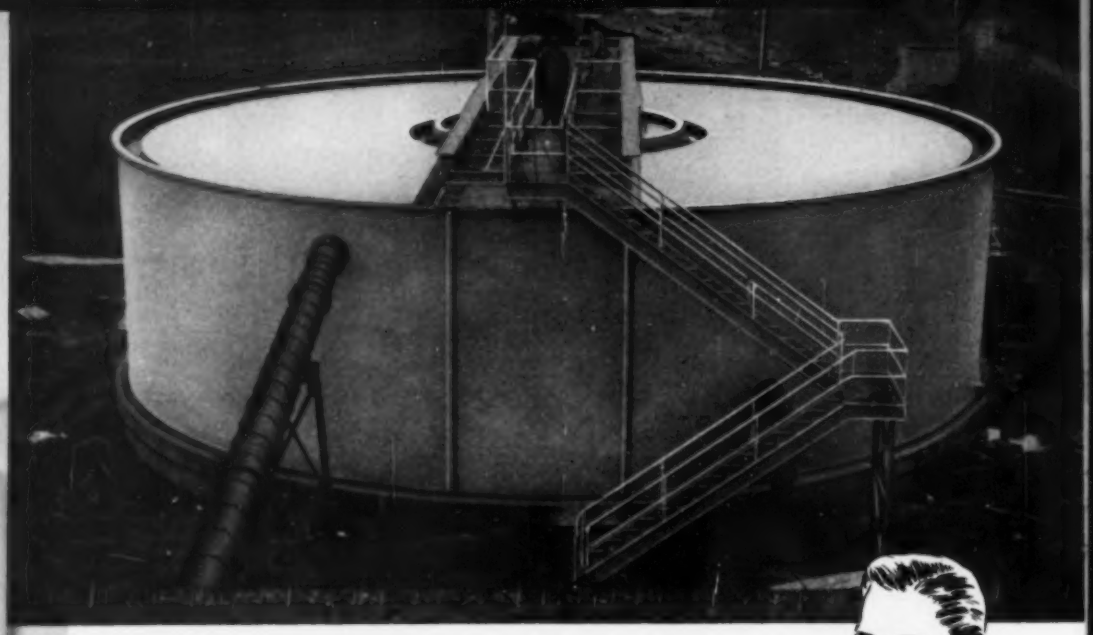
Calculations showed that if the 575-volt system were continued, a total of 180 *tons* of copper would be needed in the main secondary runs. With a load-center system, these could be replaced with three-phase 400 mcm 13,200-volt cable—containing only eight tons of copper, or *1/23rd as much.*

The load-center system was adopted and has now been installed, using General Electric equipment throughout. Besides the big saving in copper, system capacity can be doubled at any future time with no further rearrangement of conductors, switchgear or transformers. *General Electric Company, Schenectady 5, New York.*

These two double-ended unit substations feed 575-volt power to the pulp-preparation units. A foundation has already been provided, to the right of these units, for another double-ended substation if and when needed.

GONE! These 8-inch conduits were used between buildings when power was distributed at 575 volts—and more were needed. They have now all been ripped out, and replaced by single 4-inch conduits carrying three-phase 13,200-volt cables.

A *Good* waste-treatment system...



costs *far less* than you think!

HERE'S HOW ONE MAN LEARNED THIS FACT:

A paper manufacturer, faced with the problem of waste treatment in his plant, guessed that a good system would cost him a six-figure sum. To avoid paying so high a price, he sunk a considerable amount into a home-made system—which simply did not do the job. And so he called in consulting engineers.

After making a complete survey of the mill, analyzing samples of its waste, and thoroughly studying the problem, the engineers made their recommendations. They were accepted by the surprised manufacturer, and the system was built.

The waste-treatment plant cost *even less* than the supposedly-cheap makeshift equipment that had failed, and it provided an effluent completely acceptable for re-use in the mill.

It also produced some benefits the manufacturer never expected:

- **A large amount of raw stock was recovered**
- **Stream pollution was eliminated**
- **There was an important reduction in heat losses**

The manufacturer estimates the new system will have paid for itself within three years!

Maybe *you* have been putting off the question of water, sewage, or industrial waste treatment for your plant or community because you think the cost prohibitive. Don't guess; you will probably be wrong! *Call in consultants specializing in this field.*

FREE BOOKLET

FOUR WAYS TO ECONOMIZE ON INDUSTRIAL WASTES ... is a factual treatise offering much useful information on its subject. Write for your copy today! Address: Gilbert Associates, Inc., 412 Washington St., Reading, Pa.

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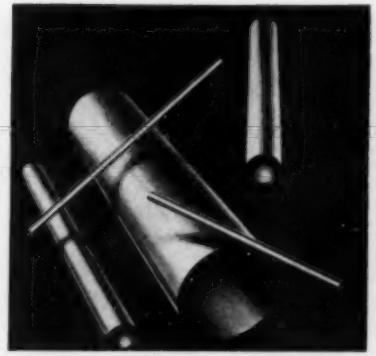

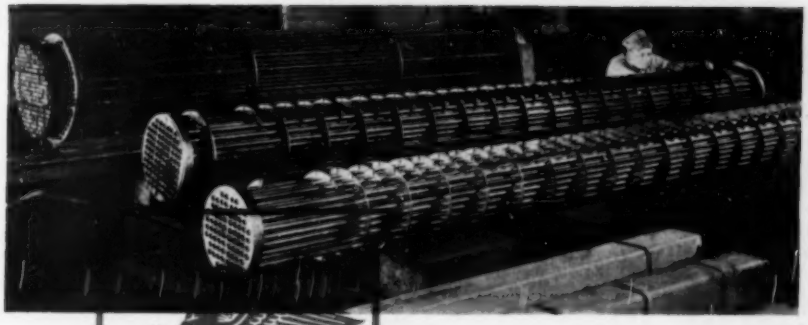

A. O. SMITH designs with TRENTWELD

When A. O. Smith, big name in steam and heat transfer equipment recently designed and built a heat exchanger unit for Socony-Vacuum — TRENTWELD Stainless Steel tubing was used throughout. This heat exchanger unit for use in the petroleum industry is another example of how TRENTWELD is preferred by designers for products where stainless steel tubing fits the bill.

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This new book brings you not only 25 practical piping layouts, arranged in convenient form for quick reference. It also includes a section on the fundamentals of valve design and application to help you select the type of valves best suited for the service.

Use it as a guide to proper valve selection and placement for longest service life and lowest operating costs. Use it also for an introduction to the wide range of Jenkins Valves for every industrial engineering and plumbing-heating service. You can obtain a copy by requesting it on your business letterhead. Address:

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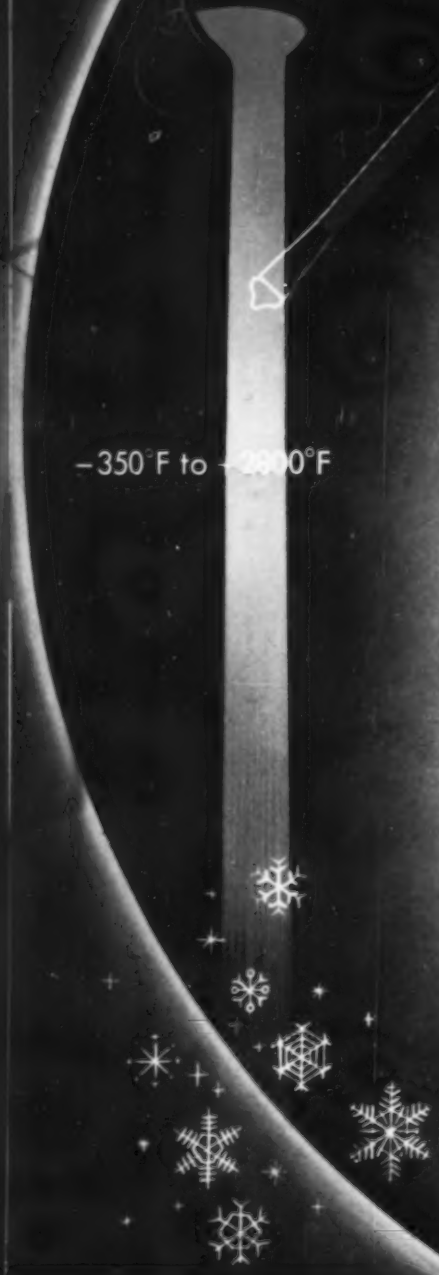

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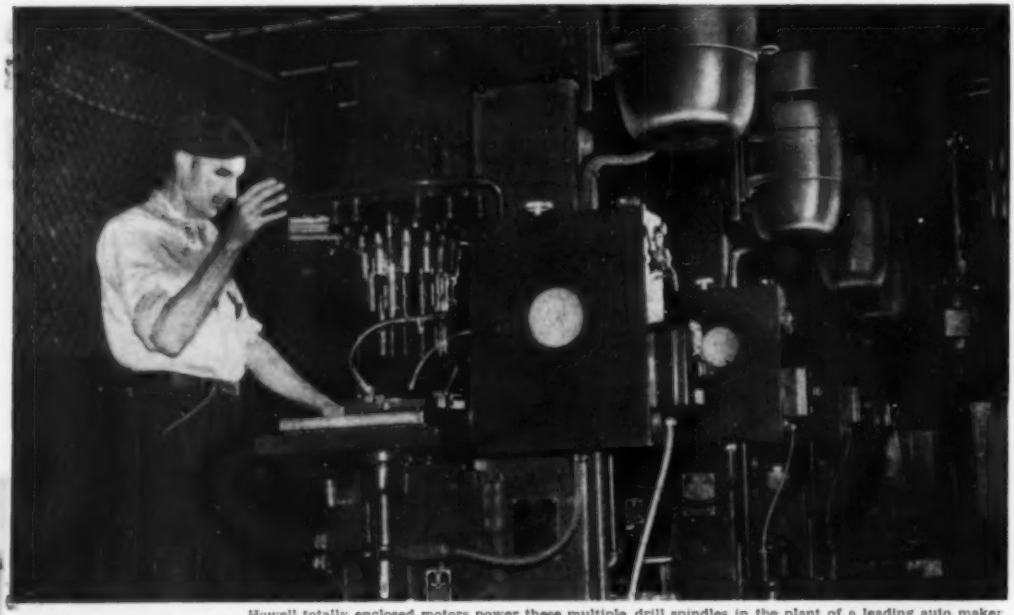

Howell totally enclosed motors power these multiple drill spindles in the plant of a leading auto maker.

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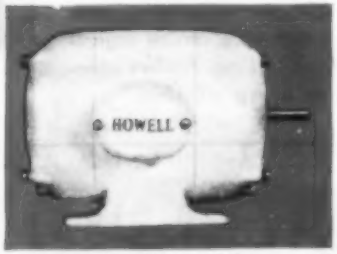
Howell Type K Motor. Offers constant performance in the presence of dirt, dust, fumes and moisture. Sizes from 3 to 150 H.P. at 1800 R.P.M. Either vertical or horizontal mounting.



Howell Sanitary Motors meet the most exacting standards of the dairy and food industries. They contain no pockets, cracks, or crevices. Available for vertical or horizontal mounting.

The actual cost of the motors you see pictured here amounts to hundreds of dollars.

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HOWELL MOTORS

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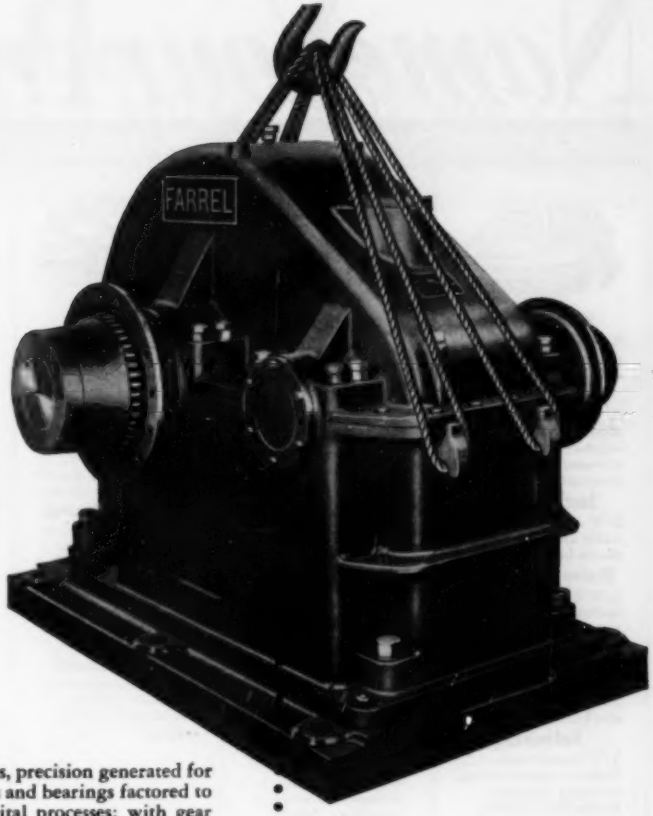

THEY ARE MADE with Farrel-Sykes gears, precision generated for smooth, quiet operation; with shafts and bearings factored to safeguard against interruption of vital processes; with gear cases proportioned to withstand repeated heavy peak loads. These are standard features of design, incorporated to assure long, trouble-free performance under normal operating conditions.

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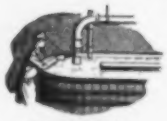

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S/V Ceremuls—Improve finish, reduce curl.

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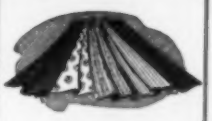

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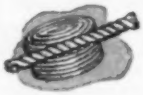

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Your Socony-Vacuum Representative will be glad to give you details—and help you apply this product to your particular requirements.

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★ **For Direct Heating of Liquids and Vapors**

★ **Indirect Heating Systems Using Circulating Medium**

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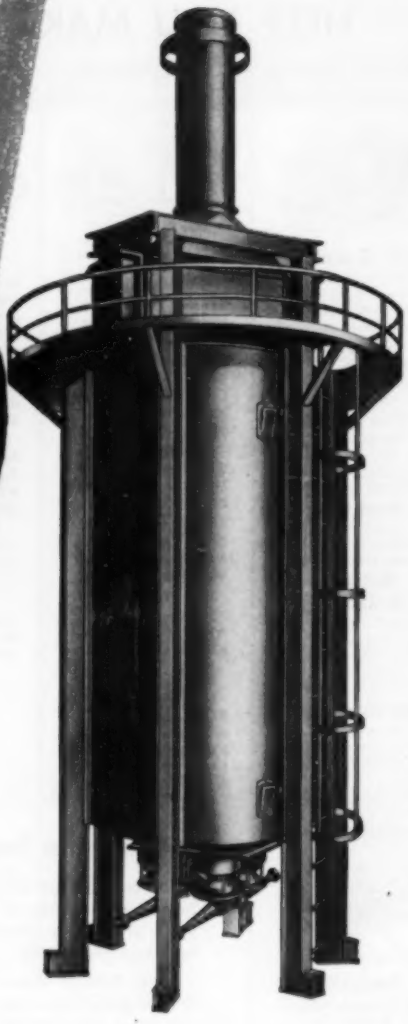
FIRED HEATERS

for the Process Industries



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2. Makes "changeovers" easier—utilizes the machine's *full* capacity—by providing the *right* speed—with the turn of handwheel or touch of button—for every operation and every operator, under every changing condition.

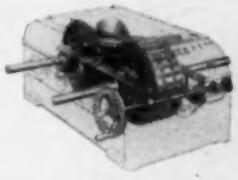
3. Wide choice of vertical and horizontal models—capacities up to 87 hp; in speed ratios of 2:1 to 16:1; manual, electric, hydraulic or completely automatic controls; suitable for mounting in any position. Also "Internals" for mounting within machine framework.

4. Easily installed on your machines. Ruggedly constructed with few moving parts subject to wear . . . requires no special tools or training to maintain.

5. Used on more different kinds of machines in a greater variety of industries than any other single variable speed drive.

Profit from REEVES Speed Control in your plant—*see immediate results.* Send for full details on REEVES Speed Control—ask for catalog No. A 68-G.

Operating Principle



REEVES Variable Speed Transmission embodies the proved operating principle of a V-belt driving between two pairs of cone-shaped discs, mounted on parallel shafts and adjustable to form an infinite number of driving and driven diameters. One shaft receives power at constant speed from motor, line shaft, etc. Other shaft delivers power at infinitely variable speeds to driven machine. Each speed setting is held without fluctuation. Operation is practically noiseless.

REEVES PULLEY COMPANY · COLUMBUS, INDIANA

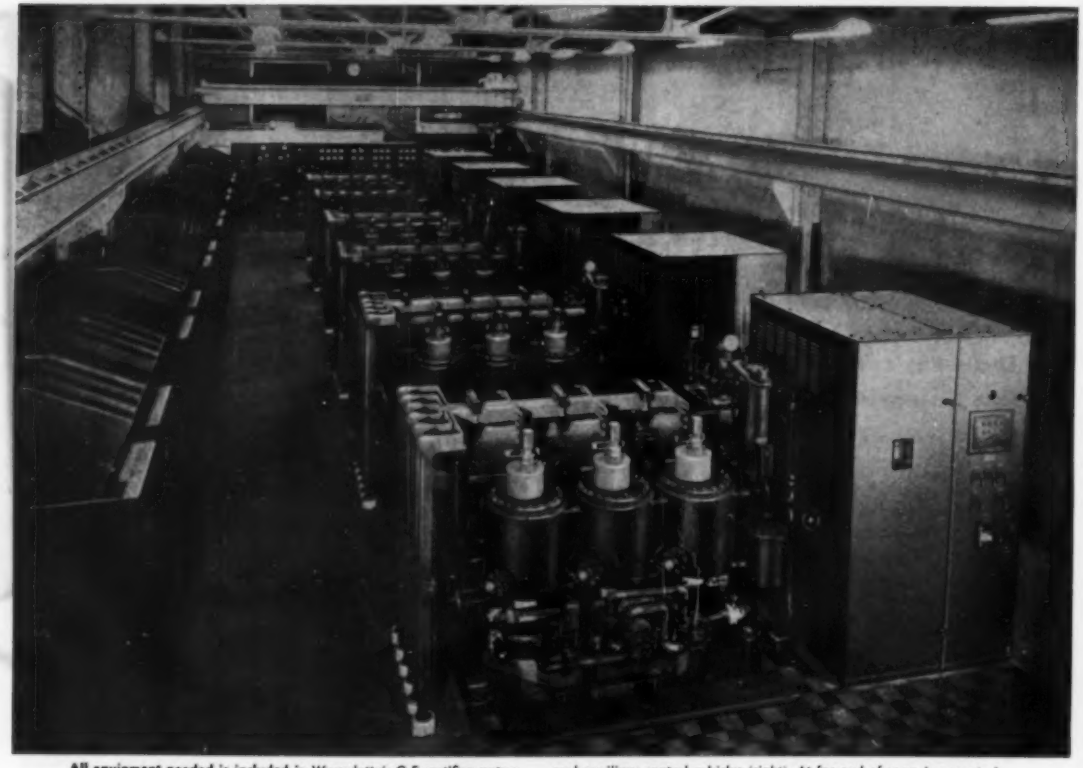
Recognized leader in the specialized field of speed control engineering

accurate · variable

REEVES *Speed Control*

A PHOTO-REPORT ON MODERN

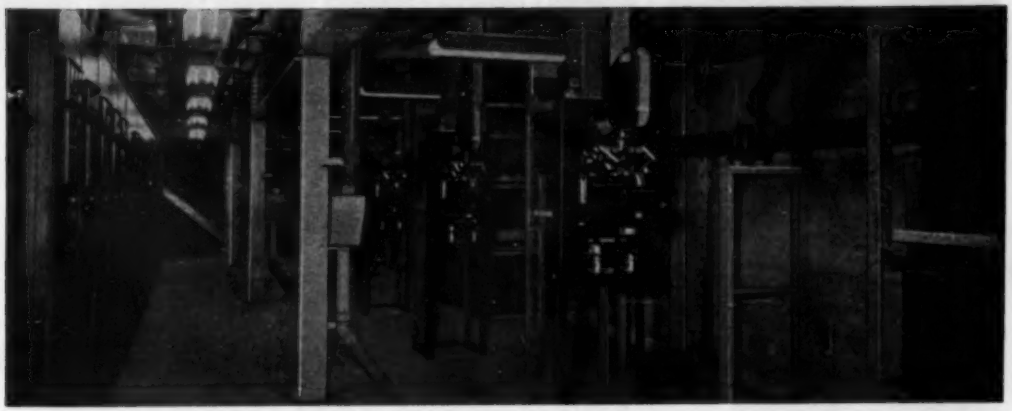
G-E rectifier system for chlorine cell line gives sure d-c power!



All equipment needed is included in Wyandotte's G-E rectifier system —from incoming power lines to load circuits. Upper floor (shown here) contains six ignitron rectifiers (center), with their anode breakers (left), and auxiliary control cubicles (right). At far end of room is operator's duplex panel, which centralizes control of all rectifiers and a-c circuits including additional equipment on floor below.

GENERAL ELECTRIC

662-37



Simple, practical layout was aided by G-E installation drawings. Lower floor houses main 13.8-kv a-c metal-clad switchgear (left) and cathode breakers (center), all controlled from operator's duplex panel on floor above. Note ample space for mounting, and easy maintenance access to cable conduits, d-c bus and disconnecting switches.

Wyandotte Chemicals Corp.—in expanding for greater production—installs complete, co-ordinated G-E system for top reliability and continuity of service

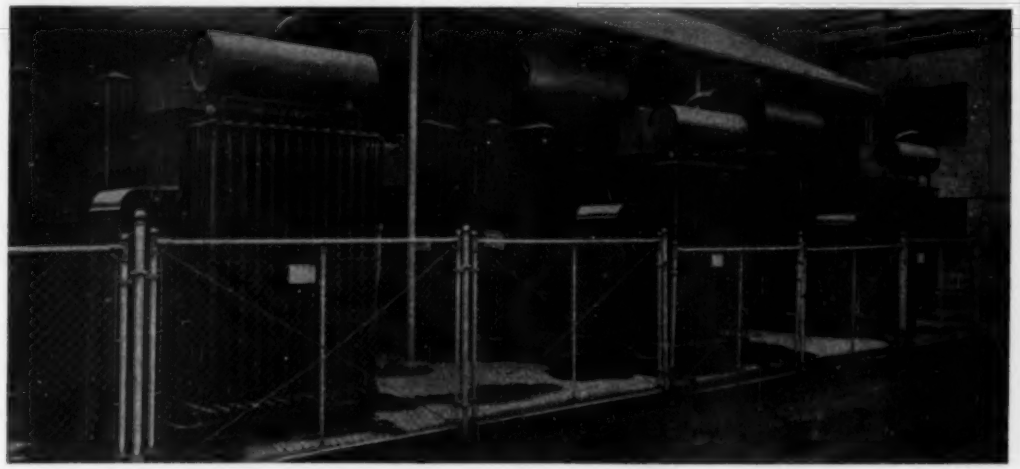
Here's another chemical plant that saved time and trouble by letting General Electric co-ordinate the electric equipment for an entire process. Of modern design and functional layout, this rectifier system embodies the reliability and service continuity that continuous electrolytic processes must have.

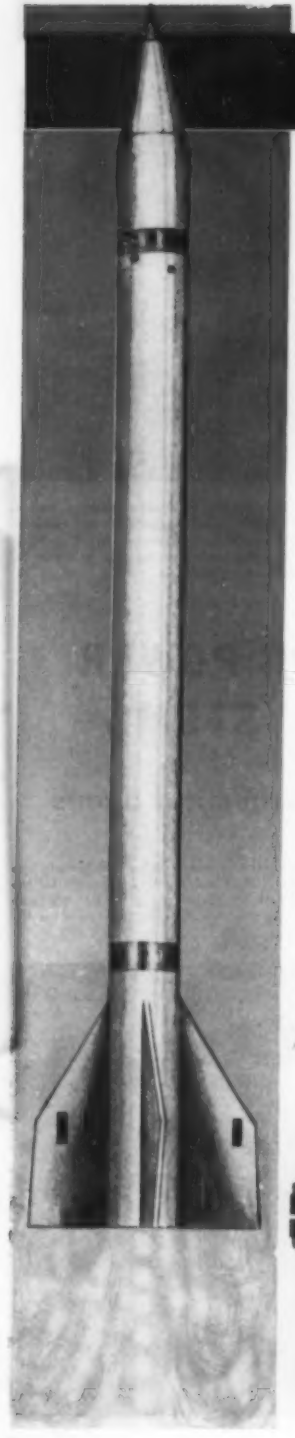
Whatever *your* chemical plant's electrical problems, an experienced G-E application engineer can help you solve them efficiently, economically. Ask your local G-E office. *General Electric Co., Schenectady 5, N. Y.*

DC POWER SYSTEMS

for electro-chemical plants

Outside the station, throat-connected to three rectifier transformers, are three autotransformers (in front), which provide flexible control for the electrolytic process. They are used for phase-shifting to give adequate multi-phase rectifier operation, and for tap-changing to provide the desired range of d-c voltage levels.





MODERN FISHER® Improved LEVEL-TROL®

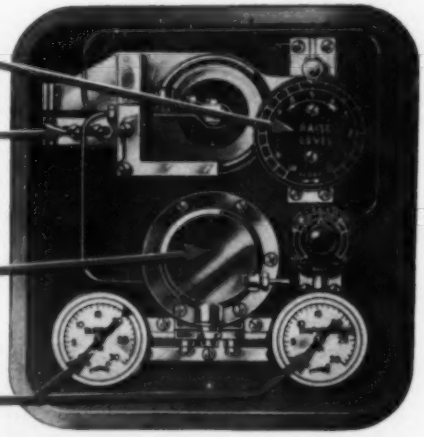
FOR LIQUID LEVEL CONTROL TRANSMISSION and INDICATION

Improved Feature
New level set adjustment. More highly visible.

Improved Feature
New factory calibrating adjustment makes possible accurate setting of proportional range over full float length.

Improved Feature
New relay—more compact—easily removed—easily assembled.

Improved Feature
Operating medium and diaphragm pressure gauges are glass-enclosed.



Type 2500-249 Level-Trol

• This improved Fisher Series 2500 Level-Trol is designed to better meet the requirements of field service—to give longer life—ease of maintenance. It still combines proportional range and specific gravity setting in one simple adjustment. Die cast weather—proof pilot case with black enamel finish, and improved lock hasp. Series 2500 Pilot Assembly is interchangeable with Fisher Series 2405 Pilot Assemblies now in service.

FISHER GOVERNOR CO.

MARSHALLTOWN, IOWA

You can't go WRONG!

when you come to POWELL

When you install Powell Valves according to Powell recommendations, you can be sure that you have the right valves to meet the actual service conditions

There's always a Powell Valve—correct in design and materials—for every flow control service.

Quality first throughout "the Line"

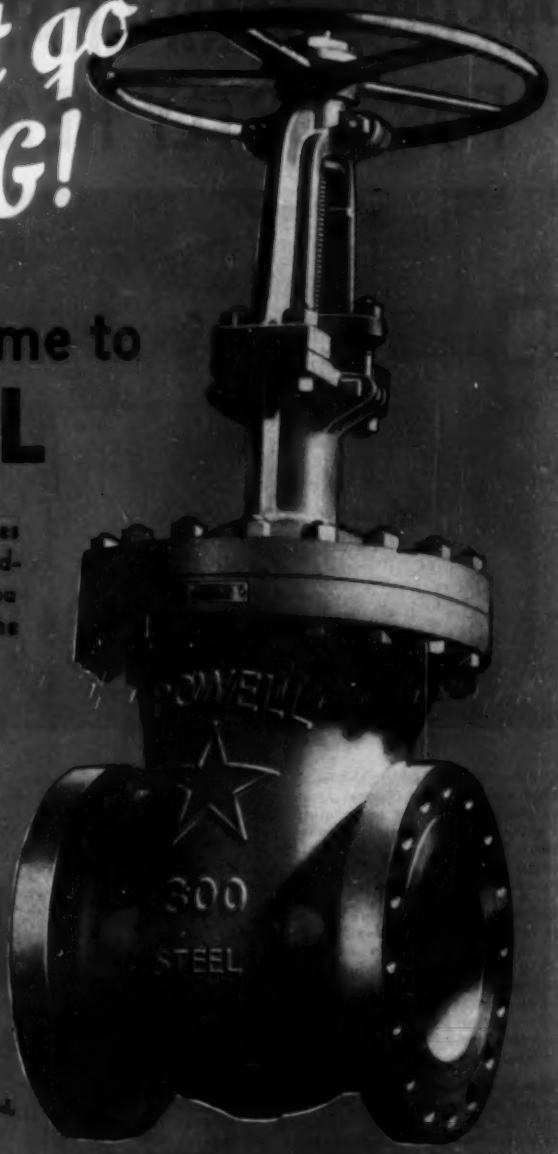


Fig. 3001—Class 300-pound, flanged end, Cast Steel O. S. & Y. Gate Valve.

POWELL

The WM. POWELL CO., 2525 Spring Grove Ave., P. O. Box 106, Station B, Cincinnati 22, Ohio

PRECISE TEMPERATURE CONTROL FOR COSTLY HEATING LOADS

PYROMETER EQUIPMENT

Type HP-3 ON-OFF pyrometer controller being used with a 25-inch air-draw furnace

Expensive loads in industrial heating furnaces are closely controlled with the new General Electric pyrometer equipment. Any change in furnace temperature equivalent to 1/10 of 1 per cent of full scale starts immediate control action when the furnace has come up to temperature. Furthermore, normal changes in humidity, ambient temperature, and voltage do not have a significant effect on the preciseness of control operation.

G-E controlling pyrometers have other features: Micrometer-type setting mechanism allows exact set-point adjustment. Dual set-points of three-position controllers can be fixed independently at any two values throughout the full-scale range. Built-in cold-junction compensation of the thermocouple prevents changes in ambient temperature at the instrument from appreciably affecting performance. And thermocouple-break protection automatically removes the load on a furnace in the event of a break in the thermocouple circuit.

This new equipment is made in indicating, protecting, and two- and three-position control forms. It is available in a variety of standard temperature ranges in the 0–3000 F span. For more details about these process instruments, get in touch with your nearest General Electric representative; or write for Bulletin GEC-713, "G-E Indicating and Controlling Pyrometers." Your local G-E salesman can also tell you about the complete line of thermocouples offered; information will be supplied if you write for Bulletin GEC-714, "G-E Thermocouples, Components, and Accessories." General Electric Co., Schenectady 5, N. Y.

General Electric's pyrometer line consists of flush- and surface-mounted indicators, controllers, and protectors. Shown above is a Type HP-3 two-position indicating controller

GENERAL ELECTRIC

602-207

What every Chemical Engineer should know about Pressure Filters

Pressure filters are probably the most commonly used filters in the processing industries and are, with few exceptions, intermittent or batch filters. Although there are many types of pressure filters on the market—disc, porous stone, cartridge, etc.—the plate-type and leaf-type are the most generally used for medium- and large-scale operations.

PLATE-TYPE FILTERS

The best known and most widely-used of the plate-type is the plate-and-frame filter press which usually employs filter cloth as a base for the filter cake. Also well known are the horizontal-plate filters which have certain definite advantages in small sizes for handling relatively small-batch operations, but which are high in cost and unnecessarily bulky when large filter areas are required.

LEAF FILTERS

There are many different types of pressure-leaf filters, such as the horizontal leaf, rotating leaf, and vertical leaf. Probably the simplest in design and most practical in application is the Niagara vertical leaf filter, employing all-metal filter leaves covered with permanent, fine-mesh wire filter cloth with openings small enough to quickly take a precoat of even the finest commercial filter-aids.

Limitations of this filter are that (1) It is a clarifying filter and cannot efficiently handle slurries with high percentages of solids; (2) It is not ideally suitable where the cake, not the liquid, is valuable.

However, it *is* ideally suited to most applications where plate-and-frame presses and other pressure filters are used for clarification purposes. Designed to combine most of the advantages of these other filters, it overcomes many of the disadvantages, particularly of the filter press, such as excessive time and labor for cleaning, poor cake-washing characteristics, bulky construction, uneven pressure distribution over total area, product leakage, non-uniform precoating, etc.

ADVANTAGES

Main advantages of Niagara Filters are:

(1) Totally enclosed, high-pressure filtration.
(2) Elimination of all labor and expenses connected with handling, washing, replacement, etc., of filter cloths.
(3) Higher rates of flow per unit filter area.
(4) Complete, sparkling filtrate clarity.
(5) Excellent cake-washing characteristics (almost true displacement washing).
(6) Greatly reduced floor space requirements.
(7) Rapid, easy cleaning and cake removal.
(8) 100% corrosion-resistant alloy metal construction . . . stainless steels, other metals if required, at reasonable cost.
(9) Easily jacketed for high-temperature operation.
(10) Maintenance almost eliminated, since there are no moving parts.
(11) One-man operation and handling, even of a battery.
(12) Unit filter area up to 500 square feet.
(13) Lower first cost where corrosion-resistant materials are required.

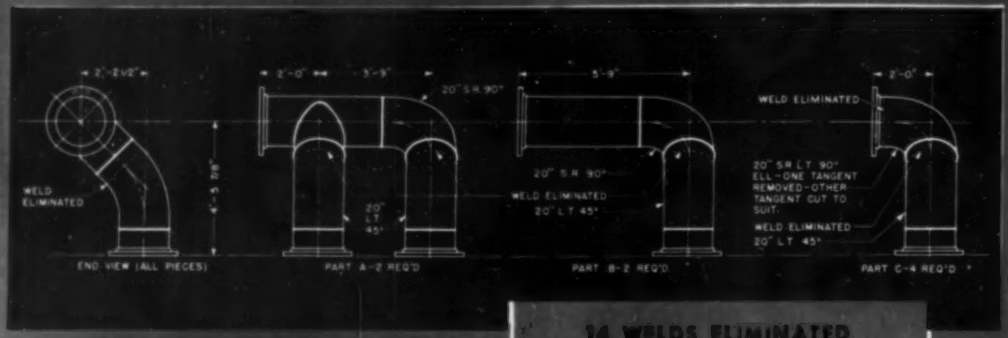
LOW OPERATING COST

This filter, although relatively new in its application to the chemical and processing industries, is rapidly replacing many of the traditional, old-style pressure filters. This trend is the result of an increasing tendency to use corrosion-resistant equipment and the realization by plant operators that lower equipment operating and maintenance costs must be achieved to keep profits up in the squeeze between increased labor and material costs and an increasingly competitive price situation.

For additional data and information on the Niagara pressure-leaf filter, the new self-cleaning "Auto-Sluice" filter, and Niagara's pilot filter rental service, write Niagara Filter Corporation, 3087 Main St., Buffalo 14, N. Y.

Advertisement.

12% COST REDUCTION... *in these piping subassemblies*



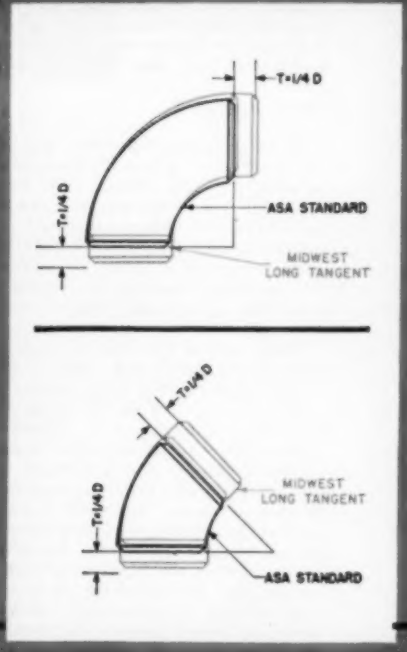
14 WELDS ELIMINATED
9'-8" OF 20" PIPE SAVED

with MIDWEST "LONG TANGENT" ELBOWS

Here is a concrete example of the extra cash value of Midwest "Long Tangent" Elbows. They saved 12% of the cost of this piping.

Each of the subassemblies shown above, if made of ASA elbows, would have required an extra nipple with an extra weld at the dotted line. With the Midwest Long Tangents, both the nipples and the welds were eliminated. Reduced material and labor costs made this substantial saving.

Other advantages of Midwest "Long Tangent" Elbows: pipe and fitting lined up more quickly and accurately, weld is removed from point of maximum bending stress, can be sleeved, slip-on welding flanges are more easily used, and they cost no more than standard elbows usually furnished. Ask for Catalog 43.



MIDWEST WELDING FITTINGS
Improve Piping Designs and Reduce Costs

MIDWEST PIPING & SUPPLY COMPANY, INC.
Main Office: 1450 South Second Street, St. Louis 4, Mo.
Plants: St. Louis, Pleasant, Los Angeles and Steelton • Sales Offices: New York 7—30 Church St. • Chicago 3—79 West Monroe St. Los Angeles 33—320 Anderson St. • Houston 3—1213 Capitol Ave. • Tulsa 3—224 Wright Bldg. • Pittsburgh 27—426 First St.

"A remarkable case of HEAT RESISTANCE"

FOR NINE YEARS, this welded cylinder—fabricated of Republic ENDURO Stainless Steel—has served as the inside baffle plate of an annealing oven.

Subjected to 1500-degree intermittent annealing temperatures, the ENDURO cylinder has suffered no damage whatsoever. Even the circumferential welds still are perfect. No wonder the production manager for the company using the furnace calls this "the most remarkable case of heat resistance" he has seen.

Performance like this has helped keep the oven continuously in operation, producing badly needed steel coils. Periodic shutdowns for maintenance or replacement of the baffle have been unnecessary. ENDURO has helped conserve other critical materials.

Throughout the process industries, ENDURO is proving its unflinching resistance to blistering heat and to sub-zero cold.

What's more, it is speeding processing through its ease of cleaning, . . . its sanitation . . . its freedom from contamination . . . its resistance to rust and corrosion and to most acids and alkalies.

To help you with any questions concerning such *new* ENDURO equipment as material restrictions allow, Republic offers an exclusive "3-Dimension Metallurgical Service." There is no cost or obligation. Just write:

REPUBLIC STEEL CORPORATION

Alloy Steel Division • Massillon, Ohio

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REPUBLIC STEEL

ENDURO STAINLESS STEEL

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SMELTING ORE ?

NON-METALLIC MELTING ?

FERRO ALLOYS ?

NON-FERROUS REFINING ?

PHOSPHOROUS FOR FERTILIZERS ?

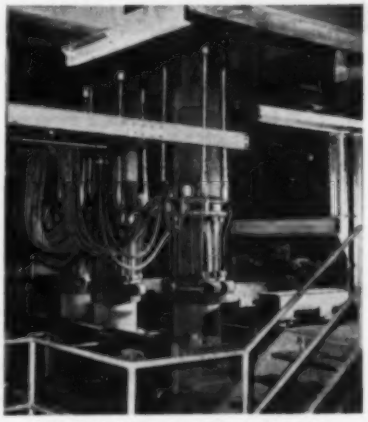
If it's a job for an Electric Furnace, *Lectromelt* will do it better

Throughout the past 34 years, Lectromelt engineers have designed and built many furnaces for various branches of the metallurgical and chemical industries. Today, with over a million and a half kilowatts of installed capacity as evidence, Lectromelt Furnace equipment is recognized as being outstanding for all types of smelting, refining and melting furnaces.

Problems in the reduction of ores and concentrates have been solved, then put on a production basis with full-scale Lectromelt Furnaces. Practically any operation that requires heat to promote a chemical or physical change can be carried out in an electric furnace. Lectromelt engineers have been conducting continuing research on electrothermic reductions, so they are able to advise you on many of those operations.

Whether you're expanding accepted processes or developing something new, Lectromelt engineers have the know-how that will probably prove a short-cut. Tell your problem to Pittsburgh Lectromelt Furnace Corporation, 303 32nd Street, Pittsburgh 30, Pennsylvania.

Manufactured in . . . CANADA: Lectromelt Furnaces of Canada, Ltd., Toronto 2 . . . ENGLAND: Birlec, Ltd., Birmingham . . . SWEDEN: Birlec, Elektrougnar A/B, Stockholm . . . AUSTRALIA: Birlec, Ltd., Sydney . . . FRANCE: Stein et Roubaix, Paris . . . BELGIUM: S. A. Belge Stein et Roubaix, Bressoux-Liege . . . SPAIN: General Electrica Espanola, Bilbao . . . ITALY: Forni Stein, Genoa.

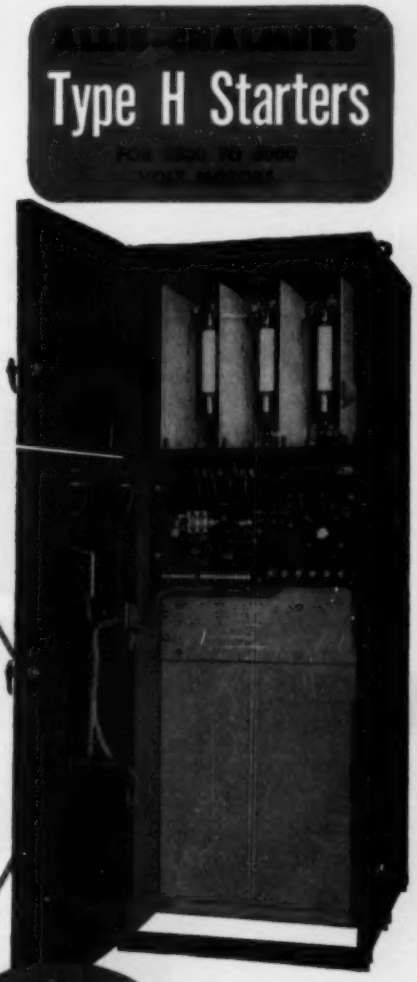


2,000-KVA Lectromelt Reduction Furnace.

MOORE RAPID

WHEN YOU MELT... *Lectromelt*

Complete Control and Protection for Your Motors



ONE ATTRACTIVE easy-to-install steel cabinet is all you need between line and motor when you specify Allis-Chalmers Type H Starters. Contactors, protective devices, meters, relays . . . everything you need for complete control and protection of your motors is built into Type H Starters. You get:

1 Short Circuit Protection . . . provided by current limiting fuses that are easily accessible.

2 Overload Protection . . . Thermal relays have compensating elements — automatically adjust for ambient temperatures — trip on motor overload only.

3 Safe, Accessible Cubicle . . . upper front compartment encloses disconnect type fuses; lower front compartment, the low voltage control devices; rear compartment, the high voltage equipment.

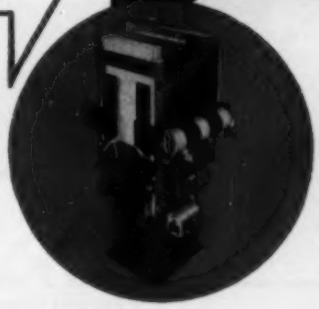
4 Easy Installation . . . single steel enclosure is easy to handle, internal wiring is complete, wiring terminals accessible, easy to connect.

5 Personnel Protection . . . high voltage fuse compartment has electrical interlock.

6 Meters, Push Buttons, Recording Instruments, Rheostats, and similar devices you may need are mounted on the door of the low voltage compartment.

Other features include undervoltage protection . . . and your choice of either air break or oil immersed contactors — whichever is best for your application.

For motor control that is engineered to your job, specify Allis-Chalmers Type H Starters for motors with ratings up to 2500 hp. Call your nearby A-C representative, or write Allis-Chalmers, Milwaukee 1, Wisconsin for bulletin 14B6410A.



Specify Type 256 Air Break Contactor, shown, for tough, repetitive duty, longer contact life . . . Type MO Oil Immersed Contactor for normal starting duty or for service in dust laden, corrosive or very moist atmospheres.

A-3389

ALLIS-CHALMERS AC

designers . . .

THE BABCOCK & WILCOX TUBE COMPANY

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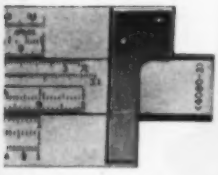
● ***for long-term exposure at 650 F. to 850 F.***

take a **CLOSER LOOK** *at*

mechanical properties



In apparatus where tubing must withstand high internal pressures at elevated temperatures, *mechanical properties* of the tubing-steel are important determinants of wall-thickness and size.

Evidently, any lasting improvement in the physical properties of a given steel will allow the designer a greater latitude in the selection of tubing, with possible advantages in the reduction of weight and cost.

Croloys 2¼, 5, and 7 have long been popular in the fully annealed state for normal service conditions up to 1250 F. Now it is established by recent B&W tests that the *increased* mechanical strength obtained by normalizing and tempering these alloys is substantially unaffected by long-term exposure to temperatures up to 650 F.; and that Croloys 5 and 7 maintain these improved properties even at temperatures up to 850 F.

Complete details of the tests are covered by Alloy Letter No. 265, available on request.

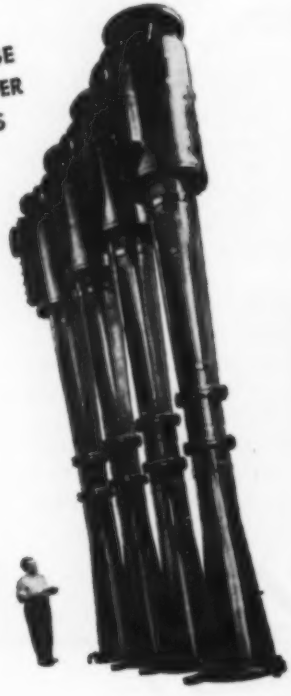
TA-1691-5

ELLIOTT Steam Jet EJECTORS

Now

SMALL SINGLE-STAGE

MULTI-STAGE and BOOSTER EJECTORS



STANDARD SINGLE STAGE

CORROSION-RESISTING

Redesigned for New Flexibility

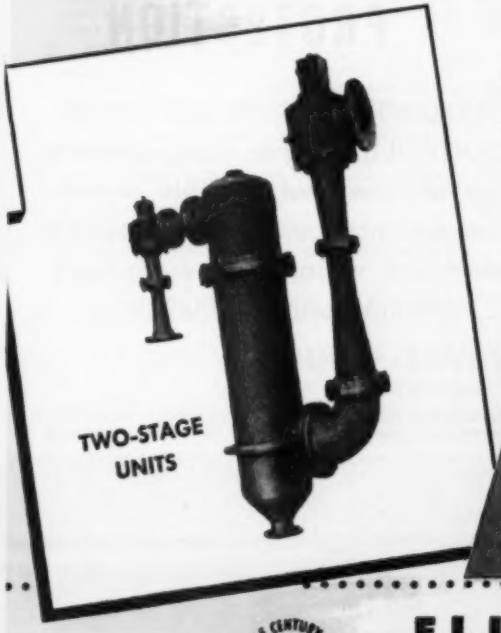
IN VACUUM APPLICATION

Without taking liberties with those design factors affecting good performance, the entire line of Elliott steam jet air ejectors has been checked over in the interests of standardization and easier application. Wherever a detail could be modified with advantage, it has been done. In the case of very large booster ejectors, a fabricated steel type has been added to cut down weight.

The end result of all this is easier, simpler application with greater flexibility, and more precise adaptation to specific conditions.

HAVE YOU A VACUUM PROBLEM?

Ask us — Elliott engineers, trail-blazers in process vacuum, have unparalleled experience in applying ejectors. They know what will work, how well it will work, what its operating cost will be, how to apply it. Use this experience, without obligation. Write us.



NEW BULLETINS READY

For up-to-the-minute specifications on any or all of the ejector types illustrated on the opposite page, ask us for the appropriate bulletins.

G-41

HALF CENTURY OF 1901 EC 1951 POWER PROCESSES

ELLIOTT COMPANY

Industrial Process Division • Jeannette, Pa.

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The CONDULET* and rigid

MECHANICAL PROTECTION

Crouse-Hinds sturdy cast Feraloy CONDULETS and rigid conduit provide the best possible protection against accidental damage to electrical wiring and equipment ... prevent costly shutdowns.

*CONDULET is a coined word registered in the U. S. Patent Office. It designates a product made only by the Crouse-Hinds Company.

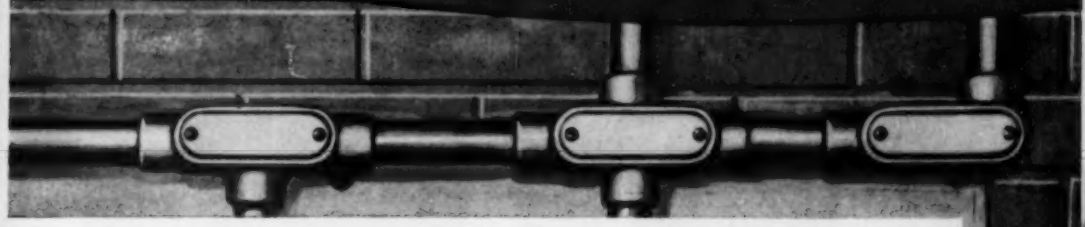
A Nationwide Distribution Through Electrical Wholesalers

CONDULETS · TRAFFIC SIGNALS

conduit method gives you

MAXIMUM PROTECTION

to wiring and equipment



Other definite advantages

- **ECONOMY.** The installed cost of Crouse-Hinds CONDULETS and rigid conduit compares favorably with other wiring methods. The added advantages make it the really economical method that pays dividends over the years.
- **SAFETY.** Ground continuity is of vital importance. CONDULETS with taper threaded hubs and rigid conduit with tapered threads make a secure joint that provides a reliable and permanent low resistance path to ground. This safety feature assures maximum protection against personal injury and fire.
- **CORROSION RESISTING.** Cast Feraloy CONDULETS give the best protection wherever moisture, dust, or corrosive atmospheres are present.
- **FLEXIBILITY.** A modern CONDULET installation provides for growth and changing conditions. CONDULETS with detachable hub plates can be used to make it easy to change circuits or add new ones.
- **UNIVERSAL APPLICATION.** You can install galvanized CONDULETS and galvanized rigid conduit under all atmospheric conditions and in all occupancies.
- **SECURE ATTACHMENT** of devices. The mounting holes in CONDULETS are drilled and tapped in the cast metal body . . . no weak mounting ears to twist off.
- **QUALITY.** The trademark CONDULET stands for the highest quality, reliability, and long life.
- **VARIETY.** More than 15,000 items are listed in the CONDULET Catalog, including a complete explosion-proof and dust-tight line for use in hazardous locations.

On YOUR next electrical layout, plan to get all the benefits of sturdy cast Feraloy CONDULETS and rigid conduit . . . the universal wiring method.

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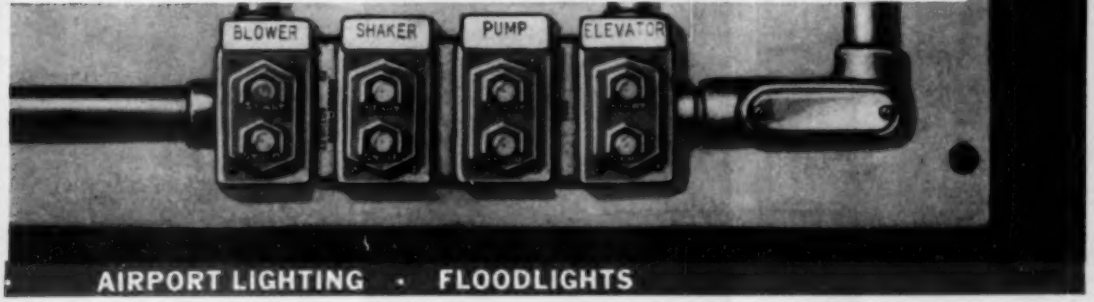
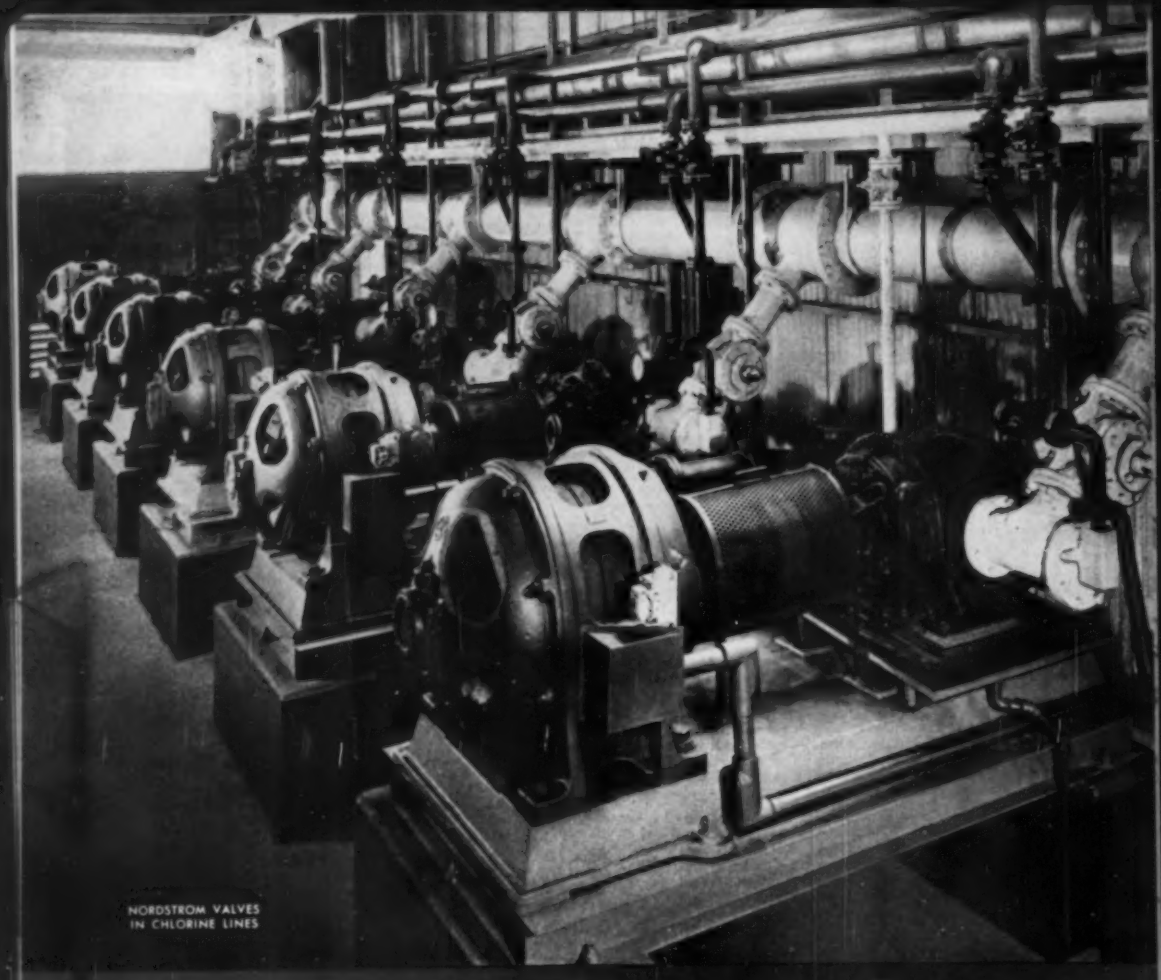
CROUSE-HINDS COMPANY OF CANADA, LTD., TORONTO, ONT.



AIRPORT LIGHTING · FLOODLIGHTS



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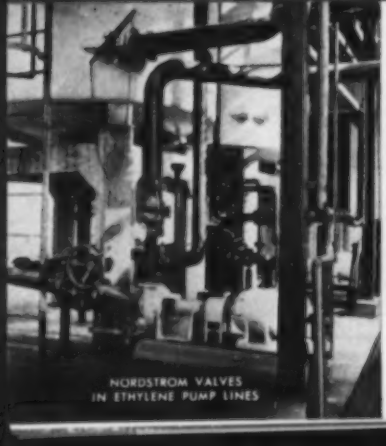
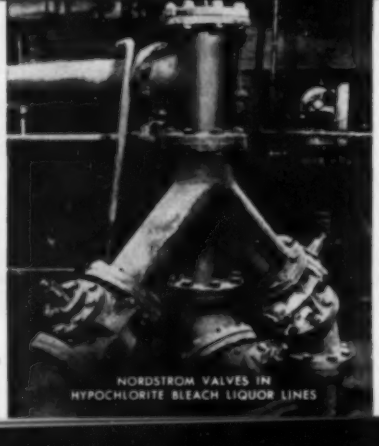
IN CHLORINE LINES

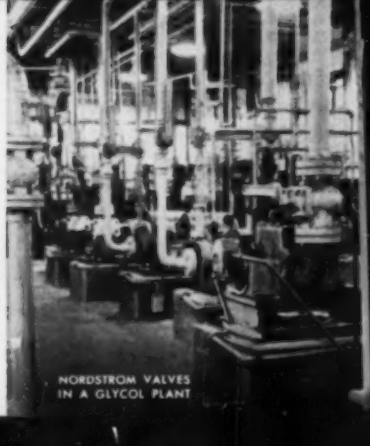
THE MOST *Saving*..



NORDSTROM VALVES
IN ETHYLENE PUMP LINES



NORDSTROM VALVES IN
HYPOCHLORITE BLEACH LIQUOR LINES



NORDSTROM VALVES
IN A GLYCOL PLANT

HOW TO SAVE 8 WAYS – WITH NORDSTROMS

1 **SAVE SHUTDOWNS**—Reduce flow line interruptions to a minimum. High resistance of Nordstrom valves to corrosion and erosion assures continuous operation.

2 **SAVE PRODUCT LOSSES**—*Tapered* plug with "Sealdport" lubrication insures against leaks.

3 **SAVE REPLACEMENTS**—Nordstrom valves guarantee longest life because seat is forever protected. Destructive abrasion does not occur at seat.

4 **SAVE OPERATING EFFORT**—A quarter-turn fully opens or closes a Nordstrom. No hammer-blow or seat forcing necessary. Plug can be hydraulically jacked if ever too tight.

5 **SAVE TIME**—You can close a Nordstrom in least time—moments against minutes. Power operated by hydraulic-pneumatic cylinder or electric motor if desired. Automatic lubrication with Hypermatic lubricant reduces maintenance to a minimum.

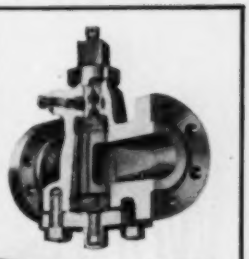
6 **SAVE SPACE**—Nordstroms do not require overhanging yokes. Least cubical dimensions. Can be set in line where space is at a premium.

7 **SAVE REPAIRS**—Positively the most enduring of all valves for chemical processing services as proved by records of low repair part costs over many years.

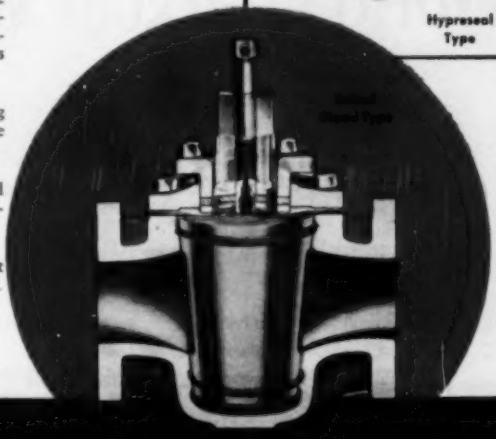
8 **SAVE PIPING**—You can install Nordstrom Multiport valves on your switching lines for 3 or 4-way control.

AVAILABLE IN SEMI-STEEL, NORDCO STEEL AND SPECIAL ALLOYS

Screwed Gland Type



Hypreseal Type



...OF ALL CHEMICAL VALVES

Nordstrom Valves

NOW AUTOMATICALLY LUBRICATED WITH Pats. Applied for Hypermatic Trade Mark

ROCKWELL MANUFACTURING COMPANY

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Atlanta, Boston, Chicago, Columbus, Houston, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco, Seattle, Tulsa...and leading Supply Houses - Export: Rockwell Manufacturing Co., International Division, 7701 Empire State Building, New York 1, N. Y.

I-R Equipment Serves the

World's Largest Cat Cracker

and the

World's Largest Vacuum Still

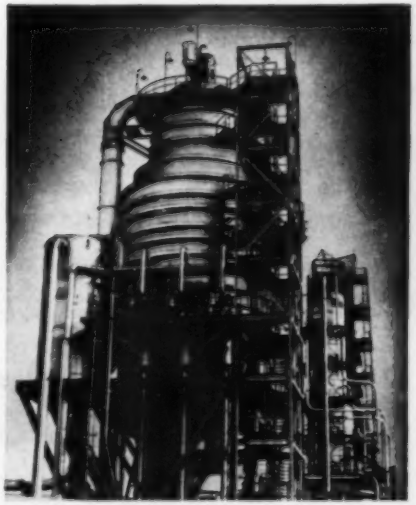
at the huge ESSO *Bayway Refinery*

Big things have been happening at the Esso Standard Oil Company's Linden, N. J., refinery.

Recent expansion included the addition of a new fluid catalytic cracking unit, and a new vacuum pipe still—*each, the largest of its kind anywhere in the world!* Both units were designed and engineered by the Standard Oil Development Company. Construction was by C. F. Braun Company of Alhambra, Calif.

In an installation of this size there is a tremendous amount of equipment required . . . blowers; compressors, both reciprocating and centrifugal; condensers; ejector units; pumps, including condensate, circulating-water, feed water, boiler-feed, etc. This machinery serves the cat cracker and the vacuum still both directly and in supporting roles.

It is significant to note that a large part of this machinery is Ingersoll-Rand equipment . . . machines that are built to stay on stream.

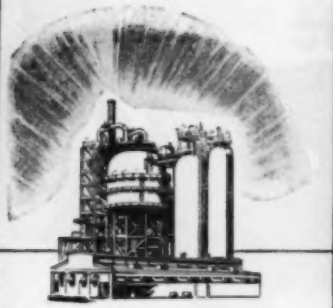


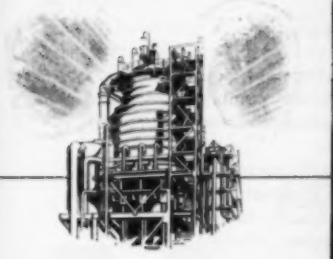
The following I-R equipment was furnished for maintaining the required vacuum on the new Vacuum Pipe Still:
DF-120 welded-steel-plate barometric condensers for use as precoolers.
Two-stage, single-element ejector units, each consisting of:
An 18 x 12 first stage ejector
A DF-3 barometric intercondenser
An 875-F40 second stage ejector.

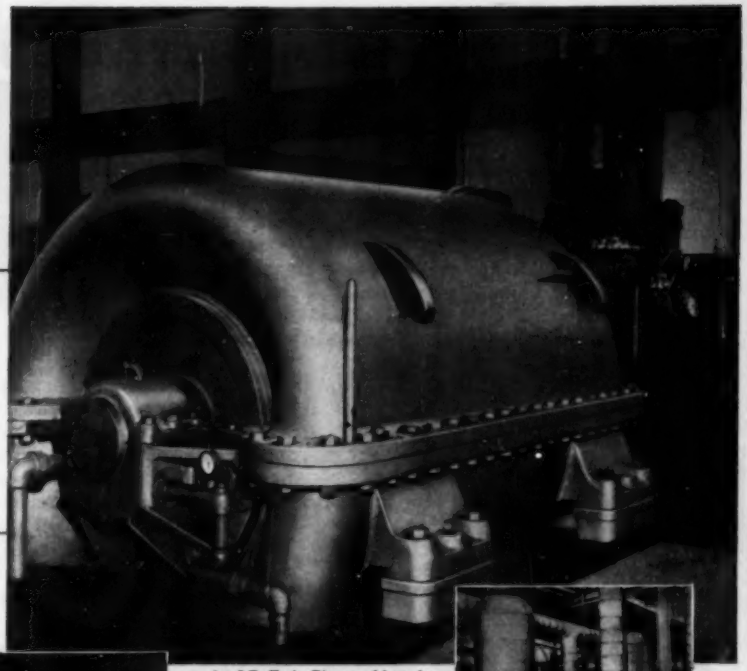
Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y. 403-14

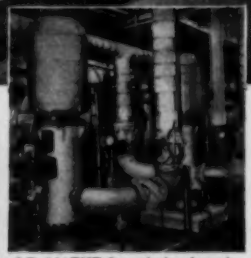
COMPRESSORS • AIR TOOLS • ROCK DRILLS
TURBO-BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS
DIESEL AND GAS ENGINES



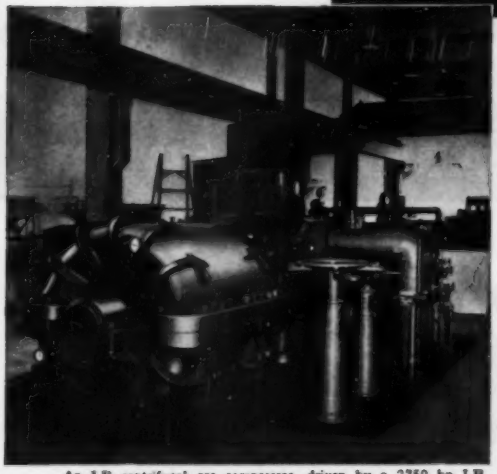




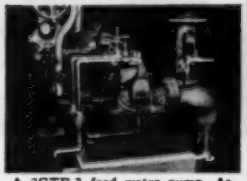
An I-R Turbo-Blower, driven by a 4530 hp Ingersoll-Rand turbine, furnishing air for catalyst blowing.



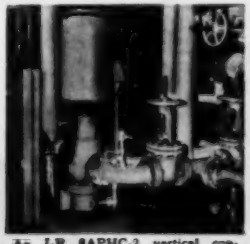
I-R 14APHR-6 vertical nebutanizing reflux pumps with Cameron Shaft Seals.



An I-R centrifugal gas compressor, driven by a 2750 hp I-R turbine, serving the absorber tower. This is the first installation using centrifugal compressors for this service.



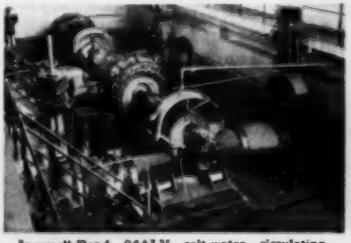
A 3QTR-3 feed water pump. Associated equipment includes I-R 1MRVH15 condensate pumps and an I-R 1½ BBFL condensate pump.



An I-R 8APHC-2 vertical condensate pump used with the surface condenser.

I-R 4HT4 high-pressure boiler feed pumps installed at the main boiler plant.

An I-R Surface Condenser serving the gas-compressor turbines. The condenser is a two-pass, vertically divided unit.



Ingersoll-Rand 24ALV salt-water circulating pumps serving the salt water pumping station, which is 100% I-R equipped.

An I-R 21½ & 13 x 12 HHE-2 ammonia compressor with 500 hp synchronous motor. Unit is equipped with 5-step clearance control.

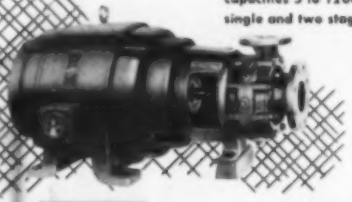
LITTLE...But Mighty Efficient

If your pump requirements call for a small to moderate size pump, you'll find the efficient, economical answer in the Fairbanks-Morse line.

Take Figure 5530 Side-Suction Centrifugal Pumps, for example. These compact, sturdy pumps are highly efficient, yet they're economical both in first and operating costs. Because Fairbanks-Morse is able to apply production line methods, with precision machining of all parts, you get the same high standards of material, workmanship and performance normally found only in highest quality split-case centrifugals.

Side-Suction Centrifugals . . . capacities 25 to 3000 g.p.m.

Builtogether Centrifugals . . . capacities 5 to 1200 g.p.m., single and two stage.



Or take Fairbanks-Morse Builtogether Centrifugals . . . the exceptionally compact units that combine motor and pump in one efficient unit. These space-savers can be installed in virtually any position.

Or take any of the small size Fairbanks-Morse pumps. Rotary, Westco Turbine Type, or small straight centrifugals. You get the same "big pump" quality and efficiency that pay off in more years of economical, efficient service.

FAIRBANKS

A NAME WORTH

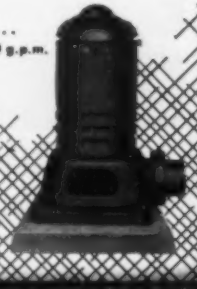
BIG..But Low in Operating Costs

Where pumping requirements demand big capacity pumps, again Fairbanks-Morse can answer your needs for more efficient, economical performance.

Two-Stage, Split-Case Centrifugals, Horizontal and Vertical Angle-flow Pump, Deepwell Turbine Pumps, Vertical Propeller Pumps . . . you'll find the pump that exactly fits your needs in the Fairbanks-Morse line. Whatever the characteristics of the particular service . . . high or low head . . . capacity . . . efficiency . . . wet or dry pit . . . basic water supply, booster service . . . transfer service . . . or liquids material handling . . . you'll get the service you want at minimum maintenance and operating costs.

Horizontal and Vertical Angle-flow . . . capacities to 100,000 g.p.m.

Horizontally Split-Case Centrifugal . . . capacities to 50,000 g.p.m.



Deep Well Turbine . . . capacities to 10,000 g.p.m.

Take the WAIT Out of Weighing Whether It's a Beam Scale..

You can weigh fast *and accurately* with a beam scale . . . if it's Fairbanks-Morse. These efficient weighing instruments were designed for easy-reading and accurate weighing.

All poises on Fairbanks-Morse Beam Scales are center indicating, full open face. Large, easily readable figures on face plates are set at a 45 degree angle to assure fast, easy reading . . . regardless of the height of the weigh-man! These Fairbanks-Morse advantages mean less chance for costly human errors . . . less "waiting on weights" . . . faster operation.

Fairbanks-Morse Beams can be furnished as standard, full capacity, or as Type-Registering with weights are printed on a card for accurate records. Beam counting scales are also available to count accurately *by weight*, small parts or pieces. Counting scales save time, money and are an essential aid in accurate inventory control.

Full Capacity Beam Scale

Beam Counting Scale

Type Registering Beam Scale

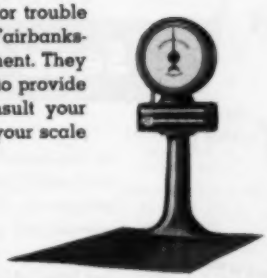
-MORSE

REMEMBERING

...OR A Dial Scale

Fast, enduringly accurate Fairbanks-Morse Dial Scales speed and simplify industrial weighing wherever they are used. Basic simple design, with an absolute minimum of moving parts, assures less chance for trouble . . . less chance for inaccuracies. There is a Fairbanks-Morse Dial Scale to fit any weighing requirement. They can be equipped with Printomatic Recorders to provide an accurate printed record of weights. Consult your Fairbanks-Morse weighing expert regarding your scale needs.

Portable Dial Scale



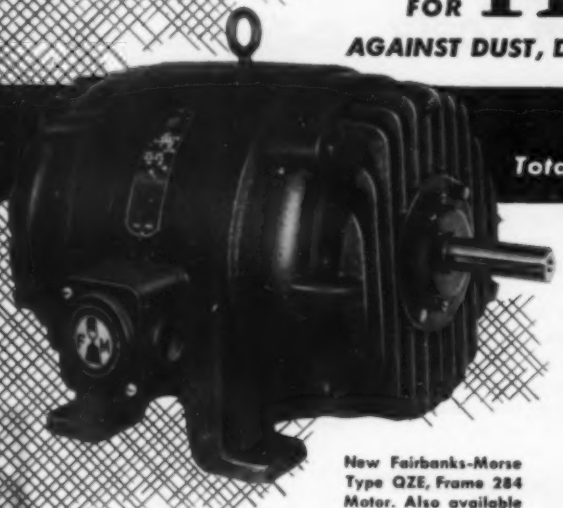
Platform Dial Scale

Bench Dial Scale

See next page for Fairbanks-Morse Sales Centers

FOR PROTECTION

AGAINST DUST, DIRT, ABRASIVES, STEAM, FUMES, ETC.



New Fairbanks-Morse Type QZE, Frame 284 Motor. Also available in smaller frame sizes.

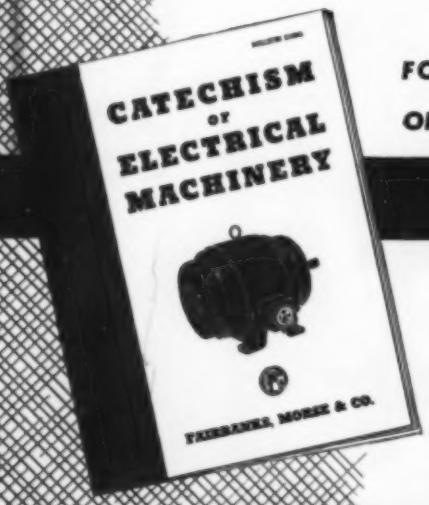
FAIRBANKS-MORSE

Totally Enclosed, Non-Ventilated Motors

For the toughest operating conditions, here is the newest development in totally enclosed, non-ventilated motors. Fairbanks-Morse Type QZE Motors are now available in Frame 284—delivering 7½ hp. at 1800 r.p.m., 5 hp. at 1200 r.p.m—filling a long-standing need for this type and size of motor. New features that assure cool, long-running service include a unique end-bell construction with cooling fins for efficient heat dissipation—and for safe, uniform, internal temperatures. For the full story on the new dependability this class of QZE Motors can bring to your most severe motor jobs, ask your Fairbanks-Morse motor representative or write Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago 5, Illinois.

FAIRBANKS

A NAME WORTH



FOR INFORMATION

ON DESIGN AND USE OF ELECTRIC MOTORS

Send for This Manual!

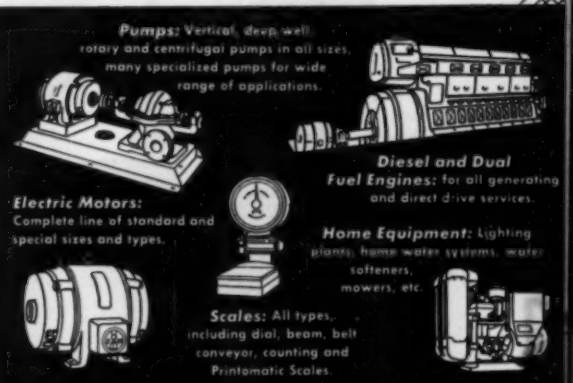
In this popular "Catechism of Electrical Machinery," you'll find an invaluable fund of basic information on the design, performance and proper use of the common types of alternating and direct current motors and generators. Primarily intended for training those who are not too familiar with electrical phenomena or terminology, it has been widely accepted by engineers, designers, and others as an aid in instruction of new men. It can be especially useful now, during this period of expanding and shifting employee rolls. Write your nearest Fairbanks-Morse Sales Center for your copy.

FOR ACTION

CALL YOUR FAIRBANKS-MORSE SALES CENTER

You can minimize procurement problems these days by depending upon your local Fairbanks-Morse Sales Center as a common source for the bulk of your requirements for electric motors, pumps, scales and diesel engines.

Fairbanks-Morse Sales Centers are staffed by factory-trained sales and service engineers who offer prompt and valuable application assistance for all Fairbanks-Morse products—as well as fast repair parts service to keep your old equipment going at top efficiency. For where to call—see the list below.


Pumps: Vertical, deep well, rotary and centrifugal pumps in all sizes, many specialized pumps for wide range of applications.
Diesel and Dual Fuel Engines: for all generating and direct drive services.
Electric Motors: Complete line of standard and special sizes and types.
Home Equipment: Lighting plants, home water systems, water softeners, mowers, etc.
Scales: All types, including dial, beam, belt conveyor, counting and Printomatic Scales.

-MORSE

REMEMBERING

THESE ARE YOUR FAIRBANKS-MORSE SALES CENTERS

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AMherst 7701

BALTIMORE 18, MD.
659 E. 25th St.
BEImont 5258

BIRMINGHAM 1, ALA.
626 N. Ninth St. Zone 4
3-6546

BOSTON 10, MASS.
178 Atlantic Avenue
LAfayette 3-3600

BUFFALO 3, N. Y.
33 Franklin St.
Lincoln 4210

CHARLOTTE 2, N. C.
Liberty Life Bldg.
Room 605
6-2893

CHICAGO 5, ILLINOIS
1550 S. State St.
HArrison 7-7100

CINCINNATI 2, OHIO
49 Central Avenue
MAin 3010

CLEVELAND 14, OHIO
3000 W. 117th St.
CLearwater 1-3300

COLUMBUS 8, OHIO
1034 Goodale Blvd.
WAlnut 8581

DALLAS 2, TEXAS
1713 N. Market Street
CEntral 4347

DENVER 2, COLO.
1500 17th Street
TAbor 6241

DES MOINES 17, IOWA
2017 Dean Avenue
6-1189

DETROIT 13, MICHIGAN
11110 East Warren Ave.
VAlley 1-7100

DULUTH 2, MINN.
Board of Trade Bldg.
2-7538

HOUSTON 13, TEXAS
5521 Navigation Blvd.
WAyside 2139—(LD 506)

INDIANAPOLIS 2, IND.
1499 N. Harding St.
FRanklin 3684
ATlantic 3092

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930 East Adams St.
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KANSAS CITY 7, MO.
1300 Liberty Street
Victor 6474

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JEfferson 8151

LOUISVILLE 8, KY.
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CAlhoun 1469

MEMPHIS 7, TENN.
676 Jefferson Ave.
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MILWAUKEE 3, WIS.
404 N. Plankinton
DAly 8-0180

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MAin 4353

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RAymond 3115

NEW YORK 4, N. Y.
80 Broad St.
HAnover 2-7470

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WA 2-4100

PITTSBURGH 24, PA.
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EAst 0131

PROVIDENCE 3, R. I.
187 Pine Street
GAspee 1-1531

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217 South Eighth St.
CHestnut 7483

ST. PAUL 1, MINN.
220-26 E. Fifth Street
GArfield 4335

SALT LAKE CITY 1, UTAH
153 W. Second South St.
3-2108 & 3-5139

SAN FRANCISCO 7, CALIF.
630 Third Street
EXbrook 2-5855

SEATTLE 99, WASH.
Salmon Bay Terminal
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STUTTGART, ARK.
403 South Main St.
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TULSA 3, OKLA.
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flexible-plastic
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THINK of the advantages Tygon Tubing offers you as a piping medium!

Its clarity permits full solution visibility all along the flow line. Its mirror-smooth, non-wetting surface means faster flow. Its non-toxic nature assures complete freedom from product contamination. The chemical inertness of Tygon, its non-aging properties, its natural toughness and abrasion-resistance mean long, trouble-free life. Tygon's true flexibility simplifies installation, and the ease with which it can be disassembled, cleaned (steam sterilized if necessary) and reassembled saves time and money.

And Tygon Tubing is available in continuous lengths in bore sizes up to 2".

May we send you more detailed information? Write the U. S. Stoneware Co., Tallmadge Square, Akron 9, Ohio.

Photograph courtesy Julius Wile & Sons Co.

96c

CLEAR, NON-TOXIC, FLEXIBLE TYGON PLASTIC TUBING PROVIDES A BETTER PIPING MEDIUM FOR LIQUID FOODS, BEVERAGES AND CHEMICALS

THE Chementator

Reg. U.S. Pat. Off.

Prepared under the editorial direction of Joseph A. O'Connor, News Editor

Low-cost ethylene oxide process

For the first time a practical process, developed by Scientific Design Co., is generally available to the chemical industry for the production of ethylene oxide by direct oxidation.

The new process cuts significantly the cost of producing ethylene oxide—by at least 25 percent. It looms as a powerful competitor of the chlorohydrin process.

What with the current squeeze in chlorine, the new process is particularly timely. It uses no chlorine, as does the chlorohydrin process. Instead, it simply oxidizes ethylene with air to produce essentially pure ethylene oxide. The chlorohydrin process is one of the biggest users of chlorine; it eats up more than 600 tons per day.

ECA has just put up $855,000 for one of these ethylene oxide units in France as part of a $12 million petrochemical expansion at L'Etang de Berre for Societe Naphtachimie. The unit will substitute for a previously planned chlorohydrin unit.

Uranium from Florida phosphate

Uranium will be recovered as a byproduct in a new $10 million phosphate plant that International Minerals & Chemical Corp. will build in Florida.

New processes will be used to produce defluorinated phosphate for animal feed and multiple superphosphate for chemical fertilizers. "Recovery of uranium compounds will be an additional step in these processes," according to President Louis Ware of International.

First buildings are already going up on a 27-acre site next to International's phosphate mines near Mulberry. When it gets into operation in about a year, the plant will produce 100,000 tons of defluorinated phosphate annually.

Clampdown on sulphuric

NPA has put sulphuric acid under complete allocation in the 11 Western States, hardest hit by the acid shortage, and is readying nation-wide controls.

Specific authorization from NPA is required to deliver or use the acid in Washington, Oregon, California, Arizona, New Mexico, Nevada, Utah, Colorado, Wyoming, Idaho and Montana. Purchasers of 60 tons a month or less are exempt.

In all other states, buyers will have to certify to their suppliers the uses to which the acid will be put. Suppliers must then report to NPA on who their customers are, how much sulphuric acid they bought and for what.

This will give NPA a clearer picture of the national pattern of sulphuric acid use. Thus the agency will be better able to devise national controls. NPA concedes that the sulphuric shortage is nation-wide.

Ethanolamine to the rescue

Output of ethanolamine will be stepped up by Dow as another important step toward bolstering the nation's dwindling sulphur reserves.

Ethanolamine is currently being used to absorb hydrogen sulphide from sour natural gas in the first stage of a process for recovering sulphur from the gas. Some of the sulphur so recovered is being converted to sulphuric acid.

Can you make these?

At the behest of the Munitions Board, researchers are pushing these projects on new products made from U.S. materials closer to commercial production: (1) research on sebacic acid, particularly for use in special lubricants, greases and tough filament nylon; (2) drying oil for paints and varnishes equivalent to dehydrated castor oil; (3) hydraulic fluid for automotive brake systems; (4) synthetic rubber modifier to replace dodecyl mercaptan; (5) emulsifier for disinfectants to replace lauryl alcohol currently used; and (6) material to substitute for palm oil in tin plating and cold rolling steel.

New price ceilings on coal chemicals

The Office of Price Stabilization has put coke, coal chemicals and coke-oven gas under a specially-tailored price regulation.

The order replaces the general freeze of January 25 with a new set of ceilings. Its issuance reflects recognition by OPS that coking is a peculiar industry with its own unique problems. That's why Stabilizer Michael V. DiSalle decided to limit profits, let producers have some leeway in fixing prices within the limitation.

The industry faced two big difficulties.

For one, coal, delivered at the plant, accounts for approximately 80 percent of a producer's operating

(*Continued on page 72*)

costs. So any increase in the cost of coal hits the industry hard. Yet that's what happened when the miners got a wage increase in January.

The second problem: coke and its byproducts are vital to defense and OPS didn't want to disturb production by imposing a ceiling that might squeeze profit margins. But the costs of recovering various byproducts have not moved up uniformly. And OPS couldn't itself set fair prices item by item, plant by plant, company by company.

Pending completion of a survey of the industry's long-term pricing needs, OPS issued its temporary order.

The regulation says that each producer may increase his ceiling price by an amount sufficient to recover the increases that have taken place in the price of raw materials since January 25. Seventy percent of such increases—in the case of coke-oven operators—must be allocated to coke products, the rest to chemicals and gas.

Producers can fix their own prices within the "chemicals and gas" area, so long as the profits earned on these products are equal to those earned during calendar 1950. The base was chosen to average out the abnormally high production of the last part of the year with the first half's low, strike-bound levels.

In addition, the order exempts coal tar and two-year contracts made prior to Dec. 19, 1950, from all price regulations.

NPA sizing up chemical industry

A survey of the nation's chemical industry is being undertaken by NPA. More than 100 producers are being asked to report. What NPA wants to find out: the industry's production capacity; the quantity of materials needed to sustain chemical output; and the end uses of chemicals.

Dye makers sing blues to NPA

The nation's dye makers want NPA to set a maximum percentage on the amount of each color they must produce to fill DO orders (30 to 50 percent has been suggested). They say this would equalize and diversify the load on their industry.

Dye makers also want NPA to delete processing chemicals such as hydrosulphides, peroxide, perborate, and wetting, dispersing and bleaching agents from coverage of Regulation 4, the maintenance and repair order (MRO). These chemicals are being drained off as "operating supplies," a committee of dye makers told NPA officials.

The dye industry can meet the needs of the Quartermaster Corps, but it would like to get some advance information on the military requirements so it can plan intelligently.

Manufacturers report some shortages in the intermediates from which vat colors are made. Anthraquinone and p-chlorophenol have been reported in especially short supply. And dye makers are also short of other chemicals: sulphur, sulphuric acid, aluminum chloride and dichlorobenzene.

Closing the gap in chlorine

Chlorine producers powwowed with NPA officials in Washington recently on the proposed $215 million expansion program for the chlorine industry.

According to NPA, need for chlorine in 1953 will be about 3,640,000 tons. Capacity now is 2,150,000 tons a year, indicating an expansion need of 1,500,000 tons.

Certificates of necessity for 35 new plants and expansion projects have already been issued to chlorine producers. This should raise capacity by about 1,123,560 tons when in full operation.

Chlorine makers kick about the trouble they're having getting building materials. And they also feel iron and steel producers have gotten better tax amortization rates.

Many industry representatives have said they could not start expanding their facilities with the relatively low tax amortization rate. Others will go ahead with expansion projects.

New galaxy of chemical plants

In mid-April the Defense Production Administration released the third list of firms receiving certificates of necessity for accelerated amortization. It listed 396 new or expanded defense facilities costing an estimated $1.3 billion.

Included are 35 chlorine plants, a $25 million synthetic fiber plant (Chemstrand); an $88.5 million nylon filament plant (Chemstrand); a $25 million acrylonitrile plant (Monsanto, Texas City); a $27 million butylene plant (Sinclair Refining, Houston); and a number of multi-million dollar gasoline plants.

USI to become part of National Distillers

Merger of U. S. Industrial Chemicals into National Distillers is virtually certain. Boards of directors of both companies have agreed to the move. All that remains is for stockholders of USI and National Distillers to approve the merger at their meetings this June. Basis of the transaction: two shares of National Distillers common stock for each share of USI common.

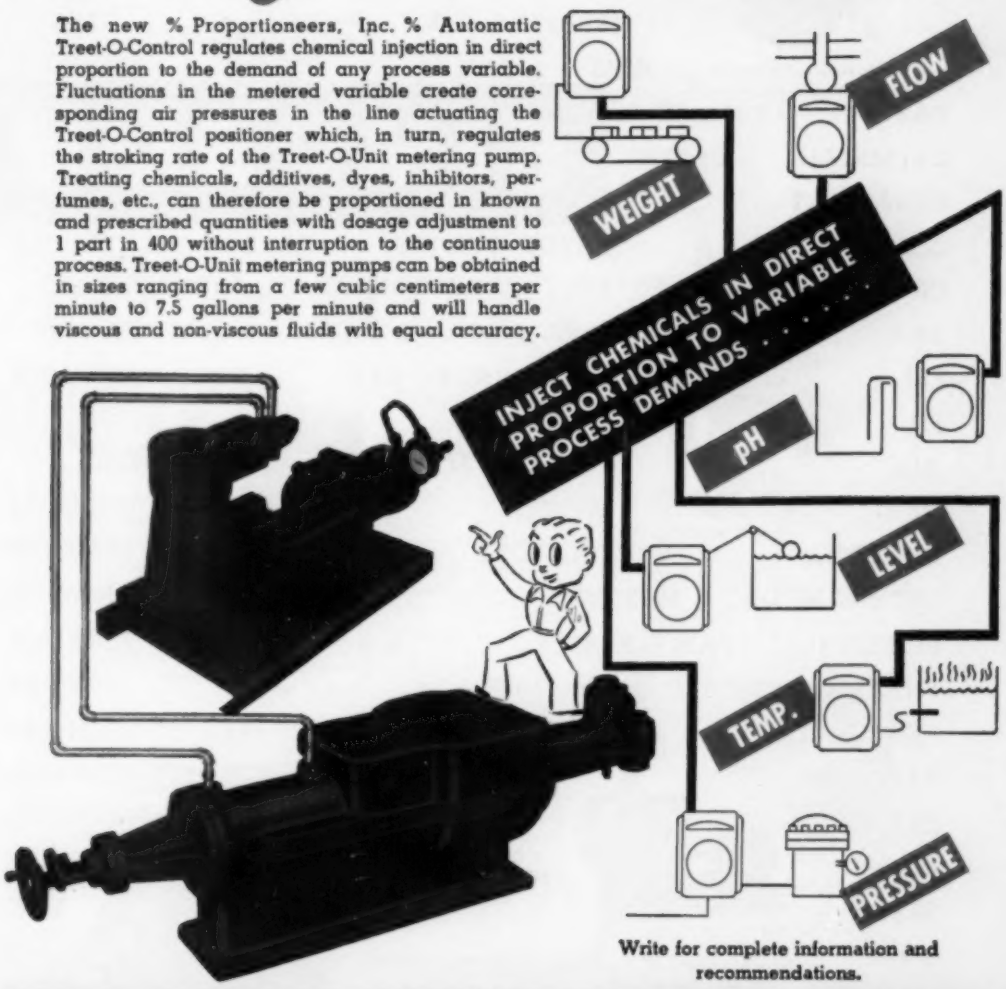
Recapitalization by Victor

Victor Chemical plans a recapitalization program. It's proposed to split the company's common stock two shares for one and to authorize a new issue of convertible second preferred stock. Arrangements are being made through F. Eberstadt & Co., Inc., for the

(Continued on page 76)

Automatic Control FOR METERING PROCESS CHEMICALS

The new % Proportioneers, Inc. % Automatic Treet-O-Control regulates chemical injection in direct proportion to the demand of any process variable. Fluctuations in the metered variable create corresponding air pressures in the line actuating the Treet-O-Control positioner which, in turn, regulates the stroking rate of the Treet-O-Unit metering pump. Treating chemicals, additives, dyes, inhibitors, perfumes, etc., can therefore be proportioned in known and prescribed quantities with dosage adjustment to 1 part in 400 without interruption to the continuous process. Treet-O-Unit metering pumps can be obtained in sizes ranging from a few cubic centimeters per minute to 7.5 gallons per minute and will handle viscous and non-viscous fluids with equal accuracy.

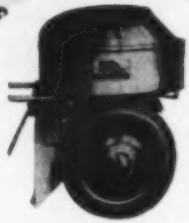


Write for complete information and recommendations.

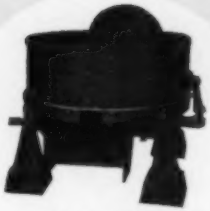
% PROPORTIONEERS, INC. %

Write to %PROPORTIONEERS, INC.%, 369 Harris Ave., Providence 1, R. I.

Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.



Porte-Muller—3'3" pan dia., 3 hp—1800 rpm—2½ - 3 cu. ft. capacity (100% Portable)



No. 1 Mixer—4' pan dia., 5 and 7½ hp—1800 rpm—3 - 4 cu. ft. capacity

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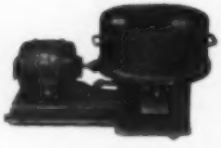
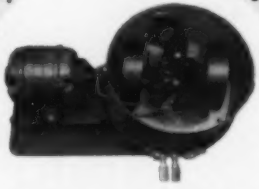
No. 0 Mixer—3' pan dia., 5 hp—1200 rpm—1 - 1½ cu. ft. capacity

No. 00 Mixer—24" pan dia., 1½ hp—1200 rpm—¼ - ½ cu. ft. capacity



Laboratory mixer—24" pan dia., 1½ hp—1200 rpm—¼ - ½ cu. ft. capacity



Laboratory Mixer—18" pan dia., ¾ hp—1800 rpm—1/10 - 1/5 cu. ft. capacity

No. 1H Mixer—4' pan dia., 5 and 7½ hp—1800 rpm—4 cu. ft. capacity (Semi-Portable)

No. 1½ Mixer—4½' pan dia., 7½ or 10 hp—1200 - 1800 rpm 5 - 6 cu. ft. capacity

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10 MODELS

UNLIMITED Mixing Applications in the Chemical-Process Industries

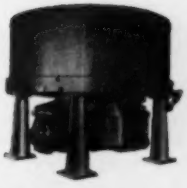
IF you prepare dry—semidry—or pasty material—in any application from Abrasives to Zirconia you can do the job *faster, much more accurately and at less cost* with Simpson Mix-Mullers.

Ten tested and proved models ranging in capacities from 1/10 to 30 cu. ft. have been engineered to accommodate practically every production schedule. They may be specially equipped for heating or cooling while mixing—for mixing under pressure or vacuum—for corrosive materials—or to function as reaction vessels.

Though vastly different in size and type of installation . . . *all* Simpson Mix-Mullers incorporate the same *true* mulling principle of mixing that has proved so successful throughout the chemical-process industries wherever accurate, controlled, mixing and blending is required.

Realize the advantages of Simpson Mix-Mullers in your own operation. Consult a National Engineer for more information today . . . or write for details about our free laboratory service to prove the results of mulling your *product in a Simpson Mix-Muller.*

No. 2 Mixer—6' pan dia., 15, 20 or 25 hp—1200 or 1800 rpm 12 - 15 cu. ft. capacity



No. 3 Mixer—8' pan dia., 40 or 50 hp—1800 rpm—25 - 30 cu. ft. capacity

SIMPSON Mix-Muller Division

NATIONAL ENGINEERING CO. 624 Machinery Hall Bldg., Chicago 6, Ill.

private sale of an additional $4 million of 20-year sinking fund notes and for the sale of $5 million of the proposed new issue of convertible second preferred.

When the recapitalization is completed and the new securities are sold, Victor's capitalization will break down like this: $9 million of 20-year sinking fund notes; 91,918 shares of 3¼% cumulative preferred stock, $100 par value; 100,000 shares of convertible second preferred, $50 par value; and 1,534,776 shares of common stock.

As 1951 began, Victor's balance sheet showed current assets of $12,197,581, including cash and $5,692,565 in government securities, compared with current liabilities of $2,239,311, or net current assets of $9,958,270. The company reported net sales for 1950 of $33,787,124, and net profits after all charges, including interest, federal, state and Canadian income and excess profits taxes, of $3,754,510.

Of fibers and high finance

First company other than Du Pont to produce nylon in the United States will be Chemstrand Corp., jointly owned by American Viscose and Monsanto. Du Pont will license Chemstrand to make nylon. In addition, Chemstrand will manufacture its own new acrylic fiber.

To finance construction of plants, Chemstrand has arranged through Morgan Stanley & Co. and Dillon, Read & Co., Inc., to borrow $110 million from institutional investors.

Total investment in Chemstrand plants will exceed $100 million. One plant is already going up at Decatur, Ala., and others will be built. Monsanto's own plant additions to supply raw materials for Chemstrand will cost more than $30 million. Major item: a $25 million acrylonitrile plant at Texas City.

Celanese keeps growing

Celanese will build a petrochemical plant at Pampa, Tex., to turn out chemicals for use in yarns and plastics, synthetic rubber, explosives, pharmaceuticals and other products. Output of the plant will supplement chemical production by Celanese at Bishop, Tex.

Fifty miles east of Amarillo in West Texas, the Pampa plant site is in the heart of a rich petroleum area that will furnish both hydrocarbon feedstocks for chemical processing and natural gas for fuel.

In another phase of its current expansion, Celanese will step up capacity of its new $35 million cellulose plant at Prince Rupert, B. C., as soon as it reaches full production. Its initial annual capacity: 70,000 tons of high-alpha dissolving pulp. Another plant will be built in Edmonton, Alberta, to make petrochemicals.

To raise capital for this expansion, Celanese plans the sale of an issue of $100 million principal amount of new sinking fund debentures, due April 1, 1976. It's also planned to refund all outstanding funded debt, amounting to $75,908,750, and to retire $44,100,000 of first preferred stock, $4.75 series, by issuing a series of preferred stock, consisting of 1 million shares at $100 par, convertible into common stock.

West's phosphorus bonanza

Phosphorus is big business in the West and getting bigger. Its third furnace nearing completion, Westvaco will start building another this year at its whopping Pocatello, Idaho, phosphorus plant. Westvaco will shell out $9.4 million for the third and fourth furnaces; their completion will bring total capacity at Pocatello to 37,000 tons a year of phosphorus.

And at Silver Bow, Mont., even though the first furnace at its new $5 million elemental phosphorus plant is not yet completed, Victor Chemical will install a second furnace, doubling Silver Bow's capacity. Victor is also expanding its phosphate plants to utilize the additional phosphorus production. When completed late in 1952, this program will increase the company's over-all phosphorus and phosphate, capacity by more than two-thirds. The enlarged program will require $9 million of added capital.

Cut-rate plutonium

Cost of plutonium production at Hanford Works has been cut in half since 1947. So reports George R. Prout, general manager of the General Electric nucleonics department that runs the plant for the Atomic Energy Commission. This despite increases in wages and salaries as well as costs of materials and supplies, he emphasizes.

GE currently has some 8,000 employees at Hanford and nearby Richland, Wash., with an annual payroll of about $65 million. It expects to add about 900 employees this year.

Levulose from beet sugar

Crystalline levulose, 1.8 times as sweet as ordinary sugar, is being turned out at a 100 lb. per week clip by the chemical engineering department of the University of Colorado at Boulder. It's made from beet sugar by hydrolysis and lime separation. Purified and concentrated, the levulose crystals, more than 99 percent pure, are centrifuged from the massecuite and air-dried. Formerly, levulose cost over $20 per lb. But in this pilot plant the price has been kept under $4 per lb. Research laboratories all over the U. S. are buying the product.

Vanillin from lignin

Early next year, Monsanto will start producing semi-refined vanillin from lignin at Seattle, Wash., where a new unit is being built. Crude vanillin will

(Continued on page 78)

Anhydrous Hydrofluoric Acid

USES OF ANHYDROUS HYDROFLUORIC ACID

Catalyst in alkylation, isomerization, condensation, dehydration and polymerization reactions

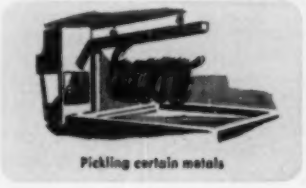
Fluorinating agent in organic and inorganic reactions

Production of fluorine

Hydrofluoric Acid (AQUEOUS)

USES OF AQUEOUS HYDROFLUORIC ACID

Polishing, etching, frosting glass



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Of all the fluorine derivatives General Chemical produces for American Industry, none has greater utility over a wider range of applications than aqueous and anhydrous hydrofluoric acid. For further information regarding the use of either of these products in your process, consult any of the 27 General Chemical offices in industrial centers from coast to coast.

Through them, the services of our resourceful technical service specialists are always available.

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Offices in Industrial Centers from Coast to Coast

be shipped to St. Louis, Mo., where refining equipment, currently used for Monsanto's vanillin from guaiacol, will be enlarged and modified. Total cost at both locations will be $1.5 million.

Lignin will be barged from the Bellingham, Wash., mill of Puget Sound Pulp & Timber Co. The lignin is a byproduct contained in the sulphite waste liquor from the pulp mill. Puget Sound gets industrial alcohol from it. Vanillin can be produced from any lignin, but the earlier production of alcohol saves one step in the vanillin process.

Manganese dioxide: not enough for batteries

A ten-fold increase in output of manganese dioxide is planned by Western Electrochemical Co. at Henderson, Nev., as a result of mounting demand for dry batteries by the Signal Corps.

Western began making the dioxide at the rate of 1 ton a day, now expects to spend about $850,000 to boost daily output to 10 tons by August, will even go to 50 tons if called upon. Low-grade manganese ore from southern Utah is made into dioxide by Western via the Schumacher process.

Dixie's first yeast plant rising

Construction has started at Belle Chasse, near New Orleans, La., on the South's first yeast plant. Instead of using grain, the new plant will produce yeast from molasses.

Red Star Yeast & Products Co. expects the plant will cost about $1.5 million. New Orleans was picked because of its ready access to the source of molasses, the availability of natural gas to make steam for power and the transportation facilities.

More dissolving pulp from hardwoods

Capacity of its dissolving pulp mill at Natchez, Miss., will be doubled by International Paper. The mill has a daily capacity of 300 tons, or an annual capacity of 105,000 tons, of dissolving pulp. What's planned is a duplication of the present plant that will bring total daily capacity of the mill to 600 tons. NPA has approved a certificate of necessity for the construction, and the added unit should be producing by the fall of 1952.

When it opened in the spring of 1950, the Natchez mill attracted widespread interest throughout the pulp and paper industry. For it was the first to produce dissolving pulp from hardwoods by a new sulphate process.

Big program mapped by Wyandotte

Bullish on the future growth of the Midwest, Wyandotte Chemicals Corp. is launching a major long-term expansion. In addition to increasing capacity for production of chlorine, caustic and soda ash, Wyandotte will add facilities for processing organics. New projects are now in the research and development stage. A new research center and pilot plant at the company's Michigan headquarters will be completed in mid-1952.

Needed: more acid for ammo

The already tight sulphuric acid situation in the St. Louis area will be aggravated by proposed reactivation of Weldon Springs and St. Louis Ordnance plants. One of the three local producers (Monsanto, General Chemical and American Zinc, Lead & Smelting Co.) will probably have to build another acid plant. Best bet: Monsanto.

Weldon Springs is a TNT plant, hence uses much sulphuric. The St. Louis Ordnance plant is a division of U. S. Cartridge Co. It's rumored that bullets will be coming out of there at full clip by January 1952. This will mean about 45,000 employees needed and a daily production of 4 million .50 cal. and 8 million .30 cal. Chemical requirements are tremendous. Sulphuric is used in the pickling tumblers.

Kentucky home for acetylene chemicals?

HARBINGER—A great new chemical center manufacturing synthetics from acetylene may mushroom in Kentucky. Forerunner of this is a new $10 million plant at Calvert City that Air Reduction will build to produce defense-vital calcium carbide. National Carbide, an Air Reduction division, will operate it. Construction starts this July, and the furnaces are expected to be running early in 1953.

FURNACES—The two electric furnaces, designed by the Norwegian company Elektrokemisk, will be the first of their kind in the U. S. for production of calcium carbide.

POWER—This National Carbide installation will devour more than 1 million kilowatt hours of TVA electricity per day, enough to meet the needs of a city of 250,000. Lime and coke will be brought in from adjacent areas.

NATURAL GAS—The 24-in. natural gas pipeline of Texas Gas Transmission Corp.—of possible future use to synthetics manufacturers—passes nearby.

CAPACITY—Initial capacity of the Calvert City plant will be 142,500 tons of calcium carbide a year. But it will be expanded to meet demand. As neighboring plants are built on the 1,000-acre site along the Tennessee River, the plant's output will be shifted more and more to use by adjacent plants. At first, however, much carbide will be shipped elsewhere.

PROSPECT—Air Reduction's President John A. Hill is confident that no other U. S. site offers as formidable an array of advantages to a synthetics industry based on acetylene.

End

Mrs. Smith IS A CAUSTIC SODA CONSUMER

That's right. Multiplied by the millions, Mrs. Smith is a *big* consumer of household products that use huge quantities of caustic soda. Soaps, cleansers, rayons, cotton and linen goods, paper products—her annual appetite for these almost numberless commodities is enormous indeed.

Equally important too, are the industrial applications of caustic soda. Today caustic soda is required for hundreds of products and processes, and the needs are constantly increasing. Established users are expanding and new users are constantly entering the picture.

Mathieson is already expanding its production to meet this increased demand and welcomes inquiries from those who might need future assistance in solving a caustic soda supply problem. Mathieson Chemical Corporation, Mathieson Building, Baltimore 3, Maryland.

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No. 999
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MORE POWERFUL • STAINLESS STEEL FRAME FOR MINIMUM HEAT CONDUCTION • LESS HEIGHT AND WEIGHT • LARGE SIZE, 2-PLY SYLPHON BELLOWS FOR ADDED POWER • SELF-OPERATING

THIS NEW ADDITION to the Sylphon line is highly recommended for all industrial processes requiring accurate, dependable temperature control. Particularly suited for storage water heaters . . . metal plating tanks . . . bottle washers . . . treaters . . . slashers . . . etc.

Like all Sylphon regulators, No. 999 is self-powered. It requires no compressed air or other auxiliary power source. It's ideal as standard equipment. Thoroughly dependable. Simple and compact. Sturdily built for long service life.

Also available with fin type bulb for controlling temperature of air or gases. Other models: 999-A has over temperature protection; 999-T equipped with dial indicating thermometer. Write for complete details. Ask for Catalog JC-A.

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Fatty Acids
Long-Chain Fatty Acid Derivatives
Industrial Oils

Durable Water Repellents from Fatty Amides

"Armid" is the Armour trade-name given to the general class of long chain fatty amides derived from fatty acids. These high molecular weight amides are high-melting, wax-like materials. The commercially pure amides are water-insoluble and neutral.

One amide in this series, Armid HT, has superior properties for water repellency applications when compared with paraffin and natural waxes.

The excellent water repellent properties of Armid HT derivatives are due primarily to the combination of the amide grouping with a long, saturated straight chain. Durability of the water repellent effect results from the relative insolubility of the derivatives under dry-cleaning operating conditions, and from their high-melting points and poor emulsification characteristics with the soaps and detergents used in laundering.

Armid HT is composed of 25% hexadecane amide, 70% octadecane amide and 5% octadecene amide, is off-white in color and has a melting point of approximately 98° C.

In contrast with the chemical inertness of the hydrocarbons, Armid HT is reactive chemically. Advantage has been taken of its reactivity with formaldehyde in particular to prepare thermally unstable quaternary ammonium salts. These are applied to fabrics from aqueous solution and decomposed under heat to leave an insoluble, durable water repellent

residue within the fabric. Reactivity with formaldehyde also permits compounding of stearamide or its derivatives with thermosetting resins to produce durable water repellent effects. Many of these thermally unstable compounds, however, are covered by patents and those patents should be consulted.

Armid HT is packaged in flake form in 100 lb. multi-wall paper bags. For samples or additional information on the Armids, mail the coupon below.

Low-Temperature Solvent Crystallized Oleic Acid

Another new product has been added to Armour's line of fatty acids. Already the manufacturer of the most complete line of high-purity distilled fatty acids that can be found anywhere, the Armour Chemical Division now offers low-temperature solvent crystallized oleic acid.

This exclusive process offers users of oleic acid a product that has advantages not found in ordinary distilled or pressed products. The extremely low temperatures employed guarantee a substantially lower saturated acid content than conventional types of oleic acid. In addition, solvent crystallized oleic acids are ester-free materials since the solvent used is not reactive with fatty acids. This new product is characterized by bland odor and has excellent heat stability.

Armour's low-titer White Oleic Acid meets U. S. Pharmacopeia specifications and is recommended for those uses that require a light color as well as a low titer. For applications that require a low titer but not a very light color, low-titer Distilled Red Oil is recommended.

White Oleic Acid
(Low Titer)

	Min.	Max.
Titer	—	5°C
Iodine No. (Wijs)	90	95
Acid Value	195	201
Saponification Value	195	201
Unsaponifiable	—	2%
Color (Lovibond 5¼" tubes)	—	1.5R-15Y

Distilled Red Oil
(Low Titer)

	Min.	Max.
Titer	—	5°C
Iodine No. (Wijs)	90	95
Acid Value	193	200
Saponification Value	193	200
Unsaponifiable	—	3%
Color (Lovibond 1¼" tubes)	—	8.0R-30Y

Armour's Oleic Acids are available in 55 gallon drums and aluminum tank cars. Write today for samples and prices.

Lard Oil Lubricants

Lard oil possesses the property of "oiliness" so essential in the lubrication field. In addition, lard oils are readily saponified when treated with alkalies and possess non-drying qualities.

Where a high grade lubricant is required, as in drawing copper and brass tubing, Extra Winter Strained Lard Oil is recommended. Its low free fatty acid content makes it ideally suited as a base for such products.

Extra Winter Strained Lard Oil is only one in a complete range of lard oils offered to the lubrication field by the Armour Chemical Division. Write today for your free copy of a chart showing "Specifications for Armour Industrial Oils."

Reading for Research Chemists

To help research chemists, the Armour Chemical Division continually prepares informative literature on chemicals derived from fats. The two technical bulletins described below are available free of charge.

For research chemists interested in fatty amines (organic bases or alkalies made from fatty acids), Armour has prepared a detailed 24-page bulletin entitled, "The Chemistry of Fatty Amines."

"The Chemistry of Fatty Acids" is the title of another technical bulletin offered by the Armour Chemical Division. It describes fatty acids, their composition, reactions, and derivatives.

Either or both of these booklets are yours for the asking. Use the coupon below to make your request.

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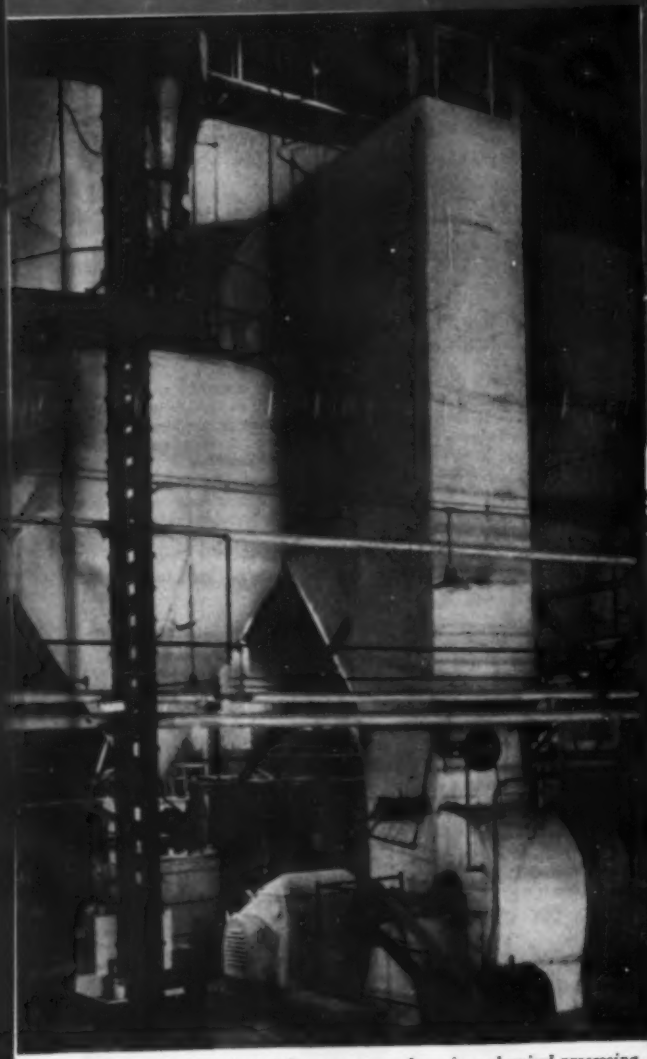
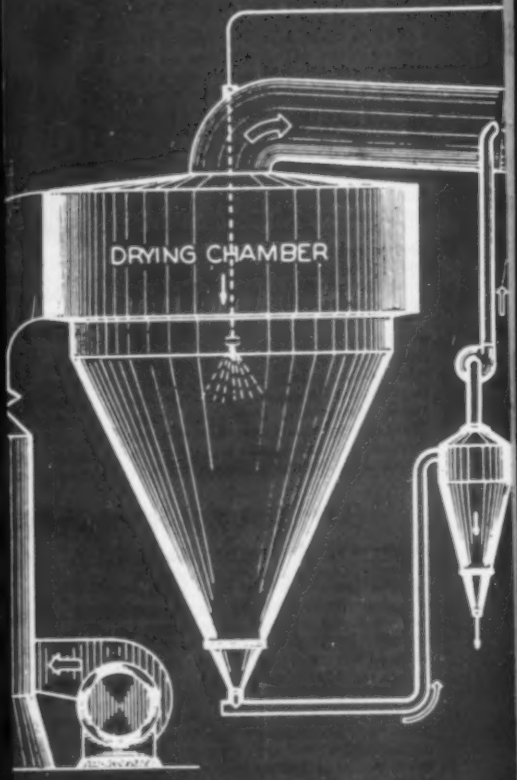
BROWN INSTRUMENTATION

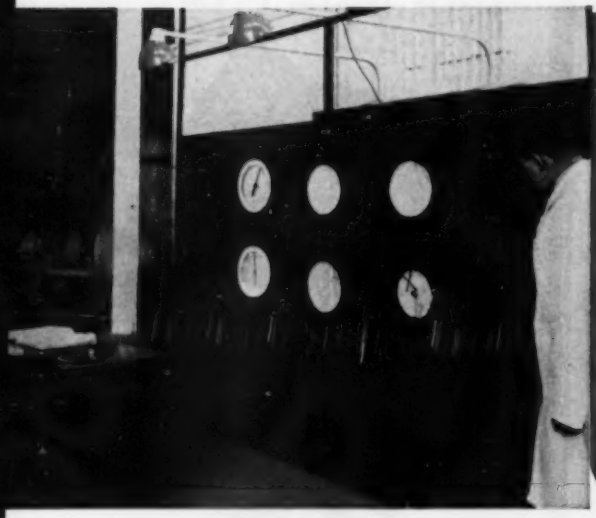
THE MODERN





Pictured is a gas-heated Swenson spray dryer in a chemical processing plant. The use of Brown automatic controls precludes the possibility of under- or over-drying by enabling an operator to: (1) control final product moisture through control of dryer outlet temperature, (2) regulate the pressure of volume and spray, and (3) control the temperature to the dryer.

APPROACH TO *Drying Control*



✱ BROWN INSTRUMENTATION

. . . is patterned to the exact requirements of individual plants and processes.

. . . is the result of engineering and application know-how, with one responsibility from sensing elements to control valves.

. . . is backed by a nation-wide field engineering and service organization.

TYPIFYING the hundreds of units that annually are yielding thousands of tons of dried chemical products is the Swenson chemical spray dryer installed at the Quebec plant of Distillers Limited.

With the help of modern Brown instrumentation, this dryer provides a new high in operating ease and efficiency. Uniform moisture content of product is obtained *automatically*, thus preventing variation in quality or deterioration of the dried material in storage.

From a centrally located panelboard of Brown instrumentation, the entire drying operation can be viewed through continuous recording and controlling instruments . . . each phase accurately recorded, rigidly controlled.

When looking for recording and controlling instruments for your drying operation . . . whether it be spray, cabinet, drum, vacuum or other . . . *consider first*

- ✱*The Brown know-how developed through many years of application experience in the industry.*
- ✱*The completeness of the Brown modern approach —recorders, controllers, panelboards, valves and all accessories.*

Call in our local engineering representative for a detailed discussion of your process requirements . . . he is as near as your phone. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4478 Wayne Avenue, Philadelphia 44, Pennsylvania.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

NOW STANDARDIZED

3 Precision Controls for All Speed Problems

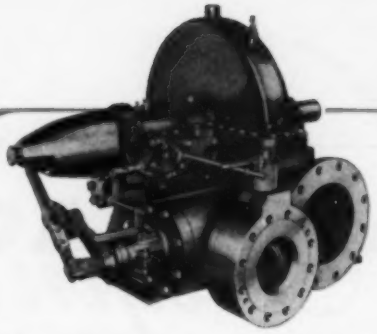
Here's governor standardization that "pays off". Now you can economically solve all speed-control problems with only three basic governors.

Costly special engineering is eliminated. Advanced design gives an unusual degree of flexibility... with precise speed control for all steam conditions. Results? Initial costs are lower... shipments are quicker... spare-parts inventory is reduced.

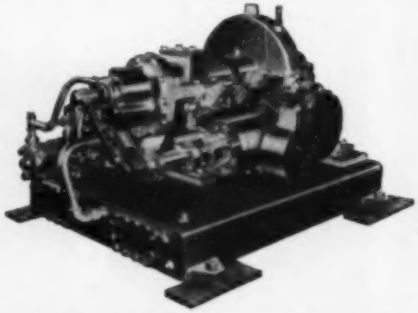
Designs for three basic classes of steam conditions, three wheel sizes, and three types of governors provide, in effect, twenty-seven standard variations to cover a wide range of applications. All oil-governed, direct-connected Type E units include the standard reservoir-type base, as illustrated. What's more, Type E governors can meet a great number of special requirements with optional accessories. This standardization results directly from Westinghouse's wide experience in all industry.

Other outstanding maintenance-saving features on the Type E turbine are Dual Protection... Weather Protection... Centerline Support... and a Rugged Governor Housing. Ratings are available from 5 to 1,500 hp.

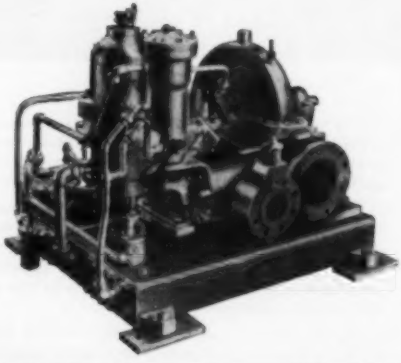
For complete information ask your nearby Westinghouse representative for Type E Turbine Book B-3896, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.



Shaft-Type Governor. For narrow speed-range applications, this governor automatically positions the steam admission valve to control turbine speed within close limits—*6 to 8% speed regulation.*



Hydraulic-Orifice Governor. For wide speed-range applications such as drives for fans, blowers, and compressors —*3-to-1 speed-adjustment range; 6% speed regulation.*



Vertical Oil-Relay Governor. For narrow-range precision-control applications such as drives for generators, pumps, blowers and compressors—*33⅓% speed-adjustment range; 4% speed regulation.*

YOU CAN BE SURE... IF IT'S Westinghouse

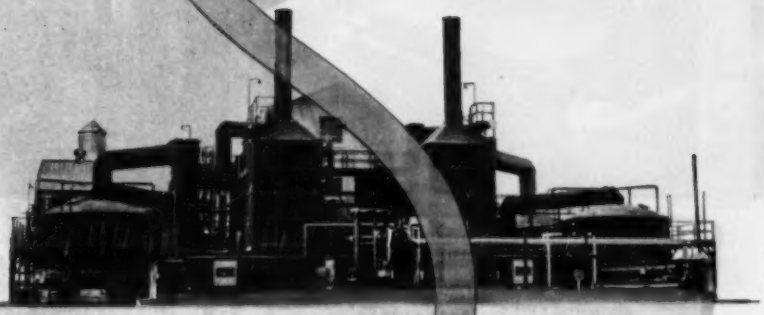
TYPE E Turbines

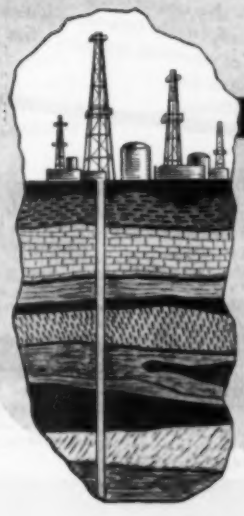
J-30527

SULFUR
RECOVERY
from waste gases

ANOTHER FOSTER WHEELER INSTALLATION—
THE LARGEST IN THE WORLD—*YIELDS*

SULFUR —from a new source





Once again, a Foster Wheeler plant proves that the recovery of sulfur from sour natural gases and spent gases in refining operations is good business. Over 300 tons of high grade sulfur per day are recovered by the Texas Gulf Sulphur Company's plant at Worland, Wyoming, which was placed in operation in April, 1950.

Today, the plants installed by Foster Wheeler have a total capacity of 600 or more tons per day, a substantial contribution to the development of the country's resources of sulfur—an essential element for the chemical, petroleum, fertilizer, steel, and other industries. Foster Wheeler has been identified with this development since the first commercial installation in the United States in 1942.

For further particulars, write:

FOSTER WHEELER CORPORATION • 165 BROADWAY, NEW YORK 6, N. Y.

FOSTER WHEELER

Here's how CMH FLEXIBLE

solves the basic motion

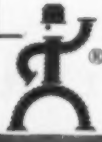
MISALIGNMENT

● For the dewaxing filter connections illustrated, CMH corrugated flexible metal hose solves the misalignment problem and compensates for expansion and contraction as well. The use of CMH Flexible Metal Hose for making connections between misaligned sections of piping frequently saves time and money . . . it eliminates the need for complicated piping and an excessive number of fittings . . . it also simplifies and speeds up assembly and disassembly of the piping.

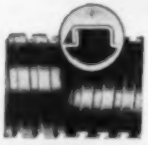
VIBRATION

● Vibration in the air compressor shown above was isolated by means of inserting short lengths of CMH flexible metal hose into the connecting lines. In all installations which incorporate vibrating components such as compressors, turbines, engines, etc., CMH flexible metal hose used as the connecting link to fixed piping effectively isolates the damaging effects of vibration and minimizes objectionable noise.

CMH
ONE DEPENDABLE SOURCE for every flexible metal hose requirement



FLEXON identifies CMH products that have served industry for over 49 years.



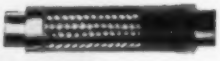
Metal Conduits in a variety of types and materials.

Convoluted Metal Hose in a variety of types—steel bronze and alloys.

Corrugated Metal Hose in steel, bronze stainless steel and other alloys.

Expansion Joints for all pressures—copper, stainless steel and other alloys.

Bellows for all requirements —brass, stainless steel and other alloys.



Standard Assemblies of metal hose components for specialized applications.

Leaders in the Science of Flexonics

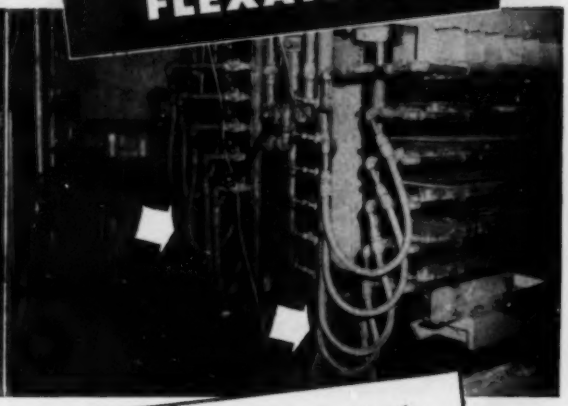
METAL HOSE

problems of conducting liquids, gases and solids

EXPANSION

● The gas connections in this boiler are subjected to expansion and contraction as the unit is brought up to operating temperature. Short lengths of CMH flexible metal hose solve this problem and eliminate the misalignment problem, too. Use CMH flexible metal hose or expansion joints in all services that include piping which is subject to expansion and contraction.

FLEXATION



● The steam connections for this rubber molding platen press are typical of how CMH flexible metal hose is used for moving connections on everything from rugged tire vulcanizers to delicate weigh tanks. When connections between moving sections are made with CMH flexible metal hose, the lines are able to offer maximum resistance to external damage and at the same time withstand high temperatures, high pressures and frequent, repeated motion for long periods.

IN CMH's complete line of flexible metal hose products there is the exact type to meet your needs. Pressures from vacuum to 12,000 psi (burst) and temperatures from far below 0° to 1600° F. can be accommodated by the various types. CMH flexible metal hose is manufactured in a wide variety of metals including types which are corrosion resistant, fire resistant and able to hold extremely searching liquids and gases.

Whatever your connection problem, if there is misalignment, vibration, expansion or flexation, CMH offers the economical, dependable, safe solution. If you do not already have literature describing the CMH line of flexible metal hose products, write for it today mentioning the types of connection problems you have.

CHICAGO METAL HOSE CORPORATION

1317 S. Third Avenue — Maywood, Illinois

Distributors in principal cities—see your classified telephone directory

In Canada: Canadian Metal Hose Co., Ltd., Brampton, Ontario

Plants at Maywood, Elgin and Rock Falls, Illinois

a a a dries LPG

(ALCOA ACTIVATED ALUMINA)

(LIQUEFIED PETROLEUM GAS)

ALCOA *Activated* Alumina has had a long and successful history of dehydration of liquids and gases. It has been particularly effective in the drying of propane and butane, the gases so important to the production of the new motor fuel, Liquefied Petroleum Gas.

Propane and butane, passed through beds of ALCOA *Activated* Alumina, are freed of their highly dispersed and dissolved liquid water, eliminating the problem of moisture in pipe lines and the hazards of frozen valves. Since ALCOA *Activated* Alumina is one of the few drying agents that will not shatter on contact with water, it is ideal for this operation. Moreover, it will not swell, soften or disintegrate . . . has high resistance to crushing, shock and abrasion . . . is non-toxic . . . non-corrosive . . . practically iron-free.

Years of use have proved ALCOA *Activated* Alumina to be one of the most effective and efficient desiccants available. Dew points as low as *minus* 100° F.—and even lower—have been obtained and under normal circumstances it can be used for an almost indefinite number of drying cycles.

If dehydration is a problem in your process, you will want to know more about this uniformly pure aluminum oxide. We'll gladly send you complete information. Write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 602E Gulf Building, Pittsburgh 19, Pennsylvania.

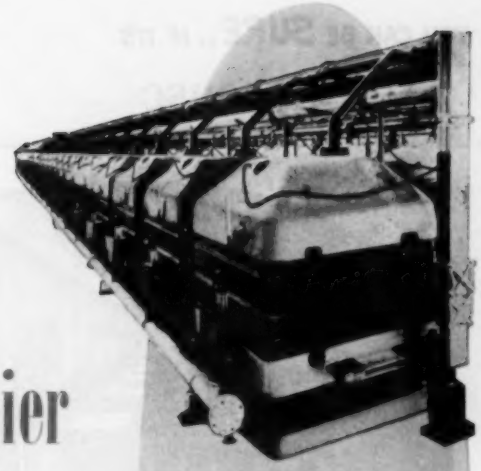
Alcoa Chemicals

ALCOA

ALUMINAS and FLUORIDES

ACTIVATED ALUMINAS • CALCINED ALUMINAS • HYDRATED ALUMINAS • TABULAR ALUMINAS • LOW SODA ALUMINAS ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUOBORIC ACID • CRYOLITE • GALLIUM

Hooker Chemicals stem from the Type "S" Cells at Niagara Falls and the high-capacity Type "S-3" Cells at Tacoma. In these cells, the highly efficient electrolysis of salt brine produces raw materials of high purity and constant uniformity, in quantity, for use by more than 30 U.S. industries.



HOOKER - basic supplier of INTERMEDIATES . . . . . .

- Benzal Chloride
- Benzoic Acid
- Benzotrichloride
- Benzoyl Chloride
- Benzyl Chloride
- Chlorobenzenes
- Chlorotoluene
- Lauryl Chloride
- Monochloroacetic Acid
- m-Nitrobenzoyl Chloride
- p-Nitrobenzoyl Chloride
- Phenyl Isocyanate
- Sodium Benzoate
- Sodium Sulfhydrate
- Thionyl Chloride

These Hooker Chemicals are widely used as intermediates by many process industries.

Starting point for all Hooker intermediates is the highly efficient Type "S" Cell. Used by Hooker and by many licensees, the "S" Cell has increased the domestic production and commercial supply of these and other chemicals.

Hooker serves you with strategically located plants and distributing stations; careful control of shipments; skilled customer service. This well-balanced supply "package" has pleased many users.

For the complete list of Hooker Chemicals, send for Bulletin 100. For properties, specifications and uses of any chemicals listed here, ask for Technical Data Sheets. Please request them on your business letterhead.

A WORD ABOUT DELIVERIES—Production of Hooker Chemicals is at an all-time peak, and plant facilities are being expanded to meet your needs as promptly as possible. For up-to-date delivery information, we suggest that you keep in touch with your Hooker sales representative.

From the Salt of the Earth

HOOKER ELECTROCHEMICAL COMPANY

5 FORTY-SEVENTH ST., NIAGARA FALLS, N. Y.

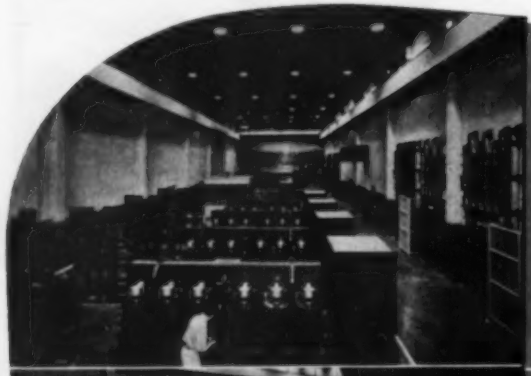
New York, New York • Wilmington, California • Tacoma, Washington

HOOKER CHEMICALS

1-516

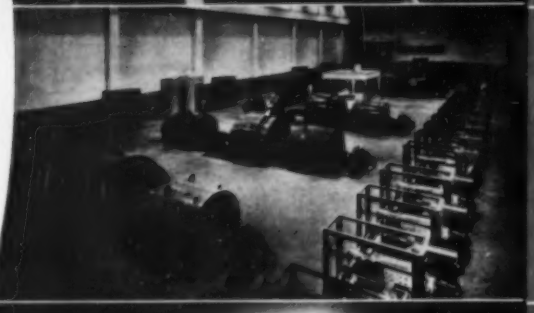
ALUMINUM CHLORIDE, ANHYD. • CAUSTIC SODA • CHLORINE • MURIATIC ACID • SODIUM SULFIDE • SULFUR CHLORIDES • SULFURYL CHLORIDE

YOU CAN BE SURE.. IF IT'S
Westinghouse



Ignitron Rectifiers—
Show Best Conversion Efficiency

Perfected by Westinghouse engineers in 1937, Ignitrons today are the chemical industry's Number One conversion method. They show the best conversion efficiency, lowest first cost for operation above 200 volts, and supply many cells in series. Ignitrons require very little maintenance and human attention (many installations are unattended). Shown at left: twelve Ignitron assemblies supply 60-thousand amps at 325 volts to electrolytic cells.

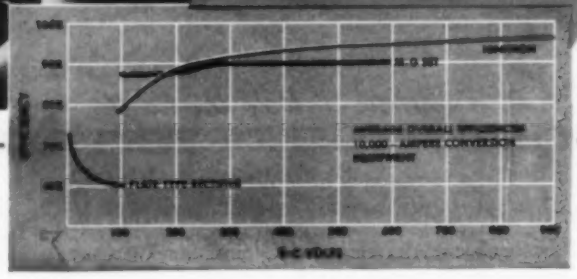


Motor-Generator Sets—
Have Wide Voltage Range

Once the leader in power conversion, M-G sets are still important where high current or variable d-c output voltages are needed. Voltage is easily regulated by controlling the generator field. For supplying 100 to 200 volts to cells in series, M-G sets have highest conversion efficiency. At left are five Westinghouse M-G sets which feed 30,000 amps to cells producing magnesium.

Plate-Type Rectifiers—
Permit Precise Cell Control

Copper-oxide and Selenium Rectifiers are best for low-voltage power (25 volts and under) for a small group of cells. They permit unusually precise cell control. Units are suited to variable output voltage. They require practically no maintenance and can readily be set up for automatic operation. Shown at left is a Selenium Rectifier for electrolytic operations. Interior of this unit is pressurized to prevent entry of corrosive gases.



ARE YOU WASTING MONEY IN POWER CONVERSION?

Conversion Method Has Big Effect on Power Costs, Cell Operation

In a big electrochemical operation, a 5% difference in conversion efficiency can make a $20,000 difference in the annual power bill. A small improvement in voltage regulation can make major improvements in cell operation. So selecting the *right* conversion method can pay big dividends in power savings, production efficiency, product quality and equipment maintenance.

Westinghouse Makes All Three; Gives Unbiased Advice

Almost every electrochemical process is different—and the tricky problem is matching the conversion equipment to the needs of your operation. Here's where Westinghouse can really help—because we've had a great deal of experience in the manufacture and application of *all three* important conversion methods. We know the advantages and best operating practice for each—Ignitrons, motor-generator sets, and plate-type rectifiers. Thus we can give you expert, *unbiased* advice in selecting new equipment or getting the most out of your present installation.

Review Your Operation; Have Westinghouse Help

A thorough study of your present conversion operations could mean big savings. A Westinghouse specialist would be glad to help you review them—with no obligation of course. Just call your Westinghouse office. And when planning new installations, be sure to call in Westinghouse early. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-94857

Westinghouse

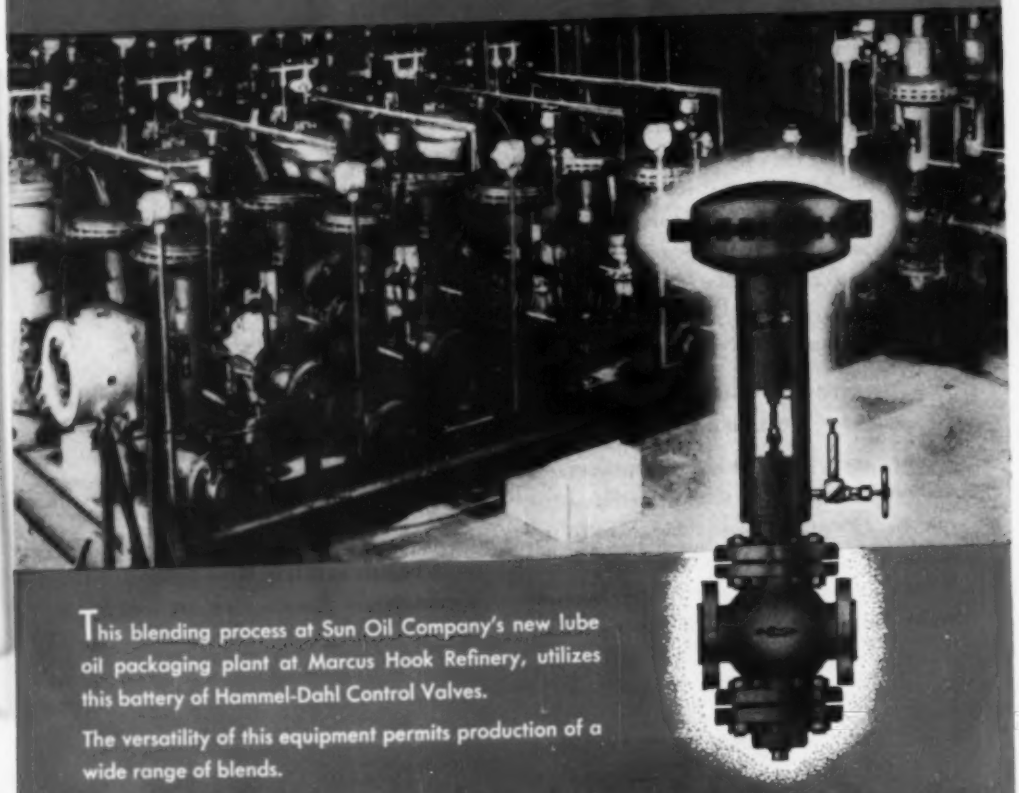
EQUIPMENT FOR THE CHEMICAL INDUSTRY

AUTOMATIC CONTROL EQUIPMENT

ENGINEERED DESIGN BY HAMMEL-DAHL

SUNOCO

QUALITY thru ACCURATE CONTROL by H-D



This blending process at Sun Oil Company's new lube oil packaging plant at Marcus Hook Refinery, utilizes this battery of Hammel-Dahl Control Valves.

The versatility of this equipment permits production of a wide range of blends.

HAMMEL-DAHL COMPANY

243 RICHMOND STREET, PROVIDENCE 3, R. I., U.S.A.

ALBANY BOSTON BUFFALO CHICAGO CINCINNATI CLEVELAND DETROIT HOUSTON KALAMAZOO KANSAS CITY KINGSPORT, TENN. LOS ANGELES NEW ORLEANS NEW YORK PITTSBURGH SAN FRANCISCO SEATTLE ST. LOUIS SYRACUSE TOLEDO TULSA WILMINGTON, DEL.

In Canada, Railway & Power Engineering Corporation, Ltd.

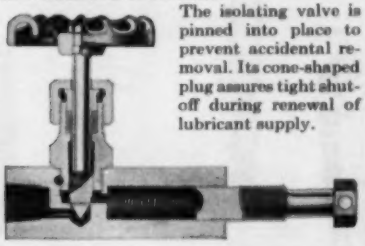
COMPARE

THIS FEATURE

OF THE HONEYWELL SERIES "700" VALVE

SAFETY STEM LUBRICATOR

The Stem Lubricator of stainless steel bar stock has an isolating valve for maintaining safe conditions *at all times*.



The isolating valve is pinned into place to prevent accidental removal. Its cone-shaped plug assures tight shut-off during renewal of lubricant supply.

Specially Designed Neoprene Diaphragm

Duplex Upper Stem Guide

One-Piece Bonnet

Packless Bellows Seal

Wide Variety of Discs

Reversibility in the Field

✻ Compare the Safety Stem Lubricator of this valve with that of any other wide band proportional type. Look at it closely . . . study it feature by feature.

Then check the other features of the valve . . . the Specially Designed Diaphragm, the Duplex Stem Guide, the One-Piece Bonnet, the Packless Bellows Seal, the wide variety of discs, the easy reversibility in the field.

Your comparison will prove that the Honeywell Series 700 has *all* of the features you look for in a fine valve.

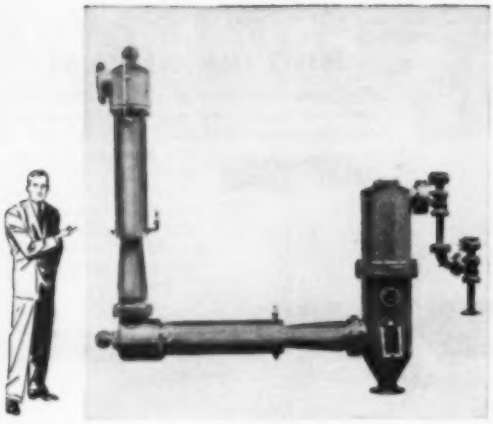
It's available in a wide range of styles and sizes. For detailed information, write for a copy of Bulletin 700-2, or call in your local Honeywell engineer . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 1904 Windrim Ave., Philadelphia 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

New Bulletin 750, "Control Valve Sizing Data," is now available

MINNEAPOLIS **Honeywell**

VALVE PRODUCTS



HIGH VACUUM?

Four-stage Worthington condensing ejector is typical of four- and five-stage units for vacuum drying and distillation processes below 1 mm Hg abs.

INTERMEDIATE VACUUM?

Three-stage Worthington condensing unit is for intermediate vacuum applications in the range from 10 mm to 1 mm Hg abs.

WHICH PICTURE

solves your vacuum problem?

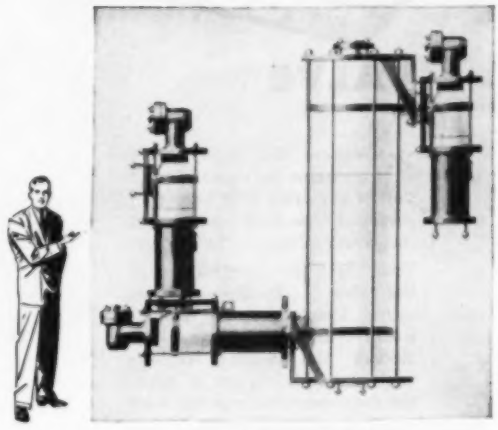
This is the *really complete* steam-jet ejector line —Worthington.

A model for every vacuum requirement—from atmospheric to 50 microns absolute. Single and multiple stages. Condensing and non-condensing.

Constructions in any material you need to resist corrosive vapors—stainless-steel, bronze, porcelain and impervious graphite—as well as cast-iron and steel.

Experience in this field reaching back to 1918 and a fund of estimating data are available to consulting engineers and end users.

For distillation, drying and other purposes, get the most out of vacuum with Worthington Steam-Jet Ejectors. *There's more worth in Worthington.* Worthington Pump and Machinery Corporation, Steam Power Division, Ejector Section, Harrison, New Jersey.

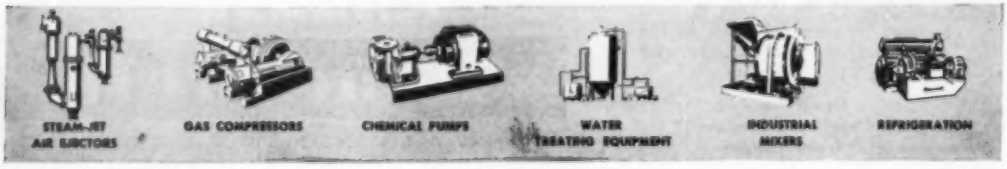


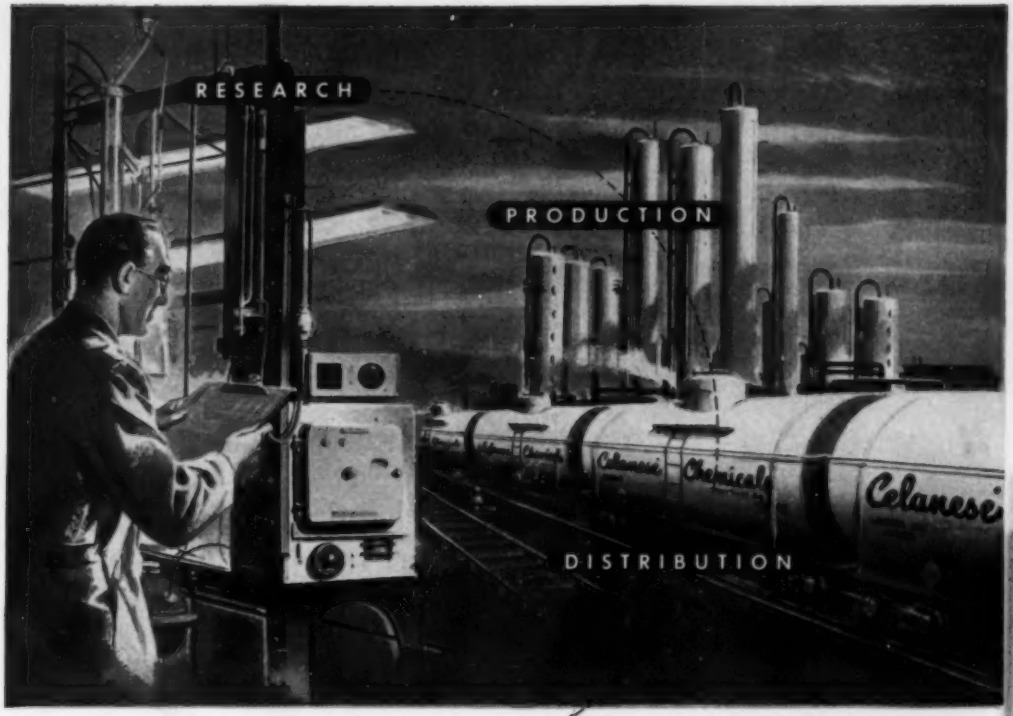
SPECIAL MATERIALS?

This Worthington unit is made of special acid-resisting material for handling highly corrosive vapors. Available in many anti-corrosive materials.

WORTHINGTON

X3.1





Chemical Formula

FOR PEAK PRODUCTION

Round-the-clock plant operation is back in style as American industry, called upon for greater output than ever before, is pushing production to new highs.

To meet the steadily increasing defense demands of industry for organic chemicals, the Celanese plant at Bishop, Texas is in continuous operation. Celanese, a major producer of Formaldehyde, Acetic Acid, Acetone, Methanol and other organic chemicals, is shipping volume quantities of these organics to the plastics, protective coatings, textile, paint and other vital industries.

Celanese chemical service to industry includes: the most up-to-date production methods . . . a nation-wide distribution system . . . and a far-reaching program of research and development backed by a generation of experience in petroleum chemistry.

Celanese Corporation of America, Chemical Division, Dept. 503-E, 180 Madison Avenue, New York 16, N. Y.

Celanese* **CHEMICALS**

*Reg. U.S. Pat. Off.

PARAFORMALDEHYDE · FORMALDEHYDE · ACETALDEHYDE · ACETIC ACID · ACETONE
BUTYL ALCOHOLS · METHANOL · n-PROPANOL · METHYLAL · TRICRESYL PHOSPHATES
BUTYLENE GLYCOLS · DI-PROPYLENE GLYCOL · PROPYLENE GLYCOL · PROPYLENE OXIDE

GLYCERINE

IMPORTANT FOR DRUGS...

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*By Government authorities responsible for inventory control under the National Defense Act.

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S W SPROUT WALDRON MUNCY, PA.

pointers to BETTER PROCESSING

SUGGESTIONS FOR PROCESSING PLANTS

MODERN CORK REDUCTION PLANT installs Sprout-Waldron Equipment ... throughout!

Illustrations show how Sprout-Waldron machines and engineering know-how tackled a diversified size reduction assignment.

Main Floor of granulating plant gives glimpse of overall operations. Note fire-proof construction, clean, compact installation.

The Hoosier Crown Corp., Crawfordsville, Indiana, makes cork seals for bottle caps.

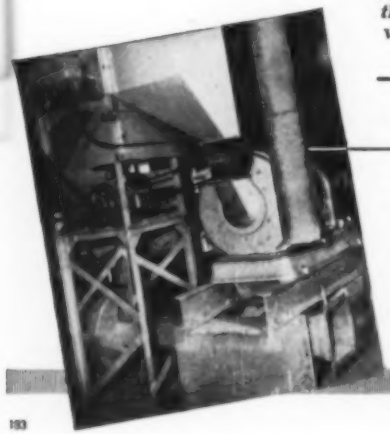
When it was decided to expand and modernize the Hoosier cork granulating plant, Sprout-Waldron was called on the job. Through close cooperation with S-W sales engineers, improved manufacturing techniques were developed. Equipment designed and built by S-W was installed to meet specialized processing requirements of Hoosier Crown Corp.

Today, installation photographs graphically illustrate another Sprout-Waldron *"success story"*—the story of successful operations achieved through the right combination of *men, machines,* and *experience!*

Consult with Sprout-Waldron on your processing problems.

1st reduction

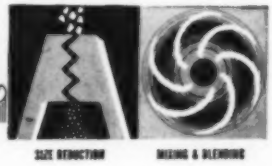
Preliminary crusher in basement makes first breakdown of cork blocker waste. Strips 10-12" long and 2" thick are reduced to 2" ring size. This unit has a higher production rate, and consumes only one-third the horsepower of previous equipment.



2nd reduction

The function of the 24" single runner attrition mill is to free the cork bark without cutting or shredding the cork wood. Equipped with specially designed plates, this mill provides a rubbing action which removes the friable "hardback" most efficiently.

LOOK TO SPROUT-WALDRON for BETTER PROCESSING EQUIPMENT



SIZE REDUCTION MIXING & BLENDING

153

SW Sprout Waldron Muncy, Pa.

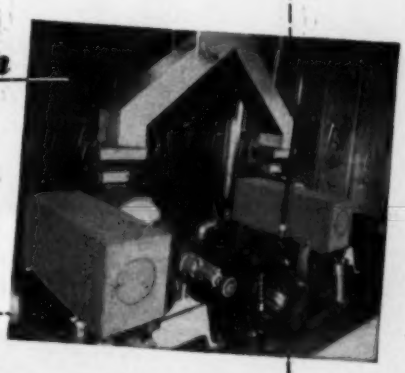
pointers to BETTER PROCESSING

SOMETHING INFORMATION FOR PROCESSING PLANTS

3rd reduction

After preliminary cleaning through bolting reel, cork is uniformly granulated to specified screen analysis by rotary knife cutter equipped with 25 HP motor. This refined cork product is now air-conveyed to two 16" buhr stone mills.

4th reduction



The two buhr stone mills illustrated serve as a buffing medium to put the finishing touches on the clean cork granules. The small shaker to the left of each mill sifts out and reclaims any cork flour produced by this scouring action.

the clean up!

From the buhr stones the buffed cork enters double disc aspirator for final "air-washing". Heavy, woody granules are removed and the clean light granules are picked up and conveyed by air to storage bins for further processing.

For further information about Sprout-Waldron Processing Equipment, and Size Reduction Systems in particular, write to Sprout, Waldron & Co., Inc., 15 Waldron St., Muncy, Pa.

Sprout-Waldron

Manufacturing Engineers

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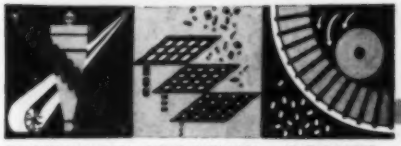

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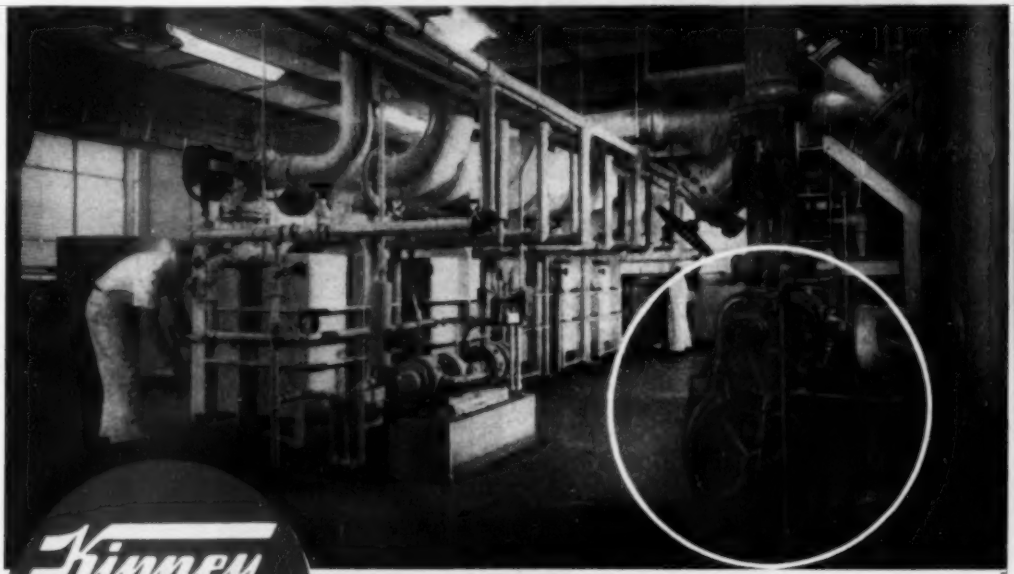

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The Life-Line chemical motor has also proved itself best for chemical service, for more than one reason. Bonderized® steel frame and brackets don't give corrosion a chance . . . have outlasted conventional motors. Sealed bearings guard against acid, dirt, moisture. Windings, extra protected by multiple layers of Thermoset varnish, stand up to extreme corrosive conditions. Enclosures, too, make sure vital parts are fully protected.

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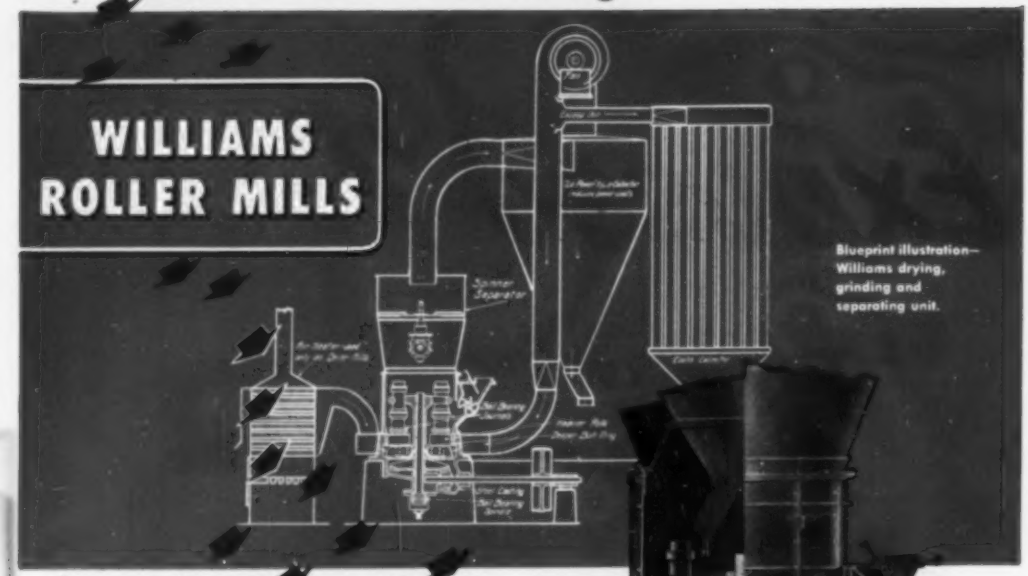
WILLIAMS ROLLER MILLS



Blueprint illustration—Williams drying, grinding and separating unit.

let's look at the record

PYRETHRUM AND OTHER FIBROUS INSECTICIDES

The Williams Roller Mill has given excellent results in the grinding of various rotenone bearing insecticides as it pulverizes the fibres to the same uniform fineness as the rest of the plant. Pyrethrum flowers can be pulverized to 98.5% passing 200 mesh. Also grinds D.D.T., Sodium Fluoride, etc.

PAINTS, PIGMENTS, DRY COLORS

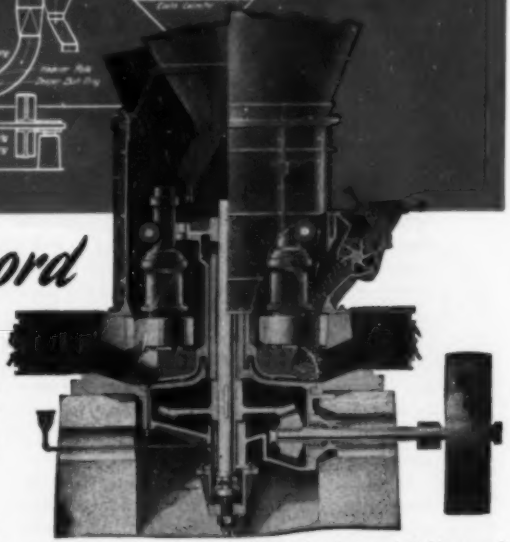
Williams Roller Mills are establishing remarkable records in the grinding of pigments and dry colors to finenesses of 99.95% 325 mesh and finer. Fineness instantly changed by varying speed of Spinner Separator Blades.

FINE GRANULATIONS

Williams has developed a special type of impact pulverizer to operate in connection with the air separator for the making of fine granulations of 30 to 80 mesh with a minimum of fines.

BARYTES, PHOSPHATE, LIMESTONE

Almost any mineral can be economically pulverized with the Williams Roller Mill. Finenesses quickly changeable from 40 mesh to 400 mesh. All can be dried and ground simultaneously by introduction of hot air.



Sectional view of Roller Mill showing how material is ground between rolls and bull ring, then air swept to Separator which extracts fines and returns oversize for re-grinding.

WILLIAMS ALSO MAKES . . .

Heavy-duty hammermills; impact and roller mills for 200 to 325 mesh grinding; drier mills; air separators; vibrating screens; steel bins; complete "packaged" crushing and grinding plants.

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SK ENGINEERING News

JET APPARATUS • HEAT TRANSFER EQUIPMENT • SYPHONES • CONDENSERS AND VACUUM PUMPS

Jet Eductors Handle Gasoline Dyes For Standard Oil Of California

Condensed from ETHYL NEWS with permission of Ethyl Corporation.

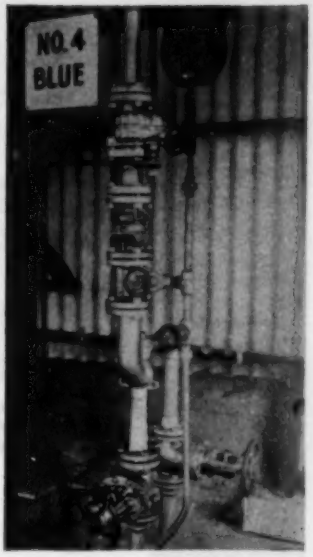
A system for handling light, easily scattered, and extremely penetrating gasoline dyes which has attracted considerable interest among process engineers is that installed by the Standard Oil Company of California at its El Segundo refinery. This system makes use of SK 1½" Fig. 222 Jet Eductors to transfer the dye, with the gasoline blend serving as the motivating, or driving, fluid.

A container of dye is placed on a scale and weighed. If, for instance, 300,000 gallons of motor fuel are to be dyed, and the dye requirements are 1.5 grams per 100 gallons, then 4,500 grams or about 10 lbs. of dye are necessary. With the proper color dye on the scale, the operator notes its weight and the reading at which he should stop the addition of dye. He inserts a flexible hose into the dye container, opens the eductor valve, and draws the proper amount from the container. After the required amount of dye has passed through the eductor, "wash" gasoline is flushed through the eductor and its connecting lines to clean them. The balance of the mixing operation—to obtain a proper proportion of dye to gasoline—is completed in the storage tank.

Separate eductors are used for each color of dye in order to avoid improper mixing. In addition, this system permits the use of individual scales for each color permitting the use of sensitive scales and avoiding the necessity for multiple handling of dye barrels.

Standard of California has found a number of advantages in its system. Dyes can be weighed accurately and added to gasoline without spilling. Time is saved by avoiding the intermediate step of making dye solutions. Turbulence in the eductor and loop lines provides sufficient mixing to put the dyes into solution. And, the system provides ease in operating and cleaning, adequate facilities for storing and handling dyes, and economical operation.

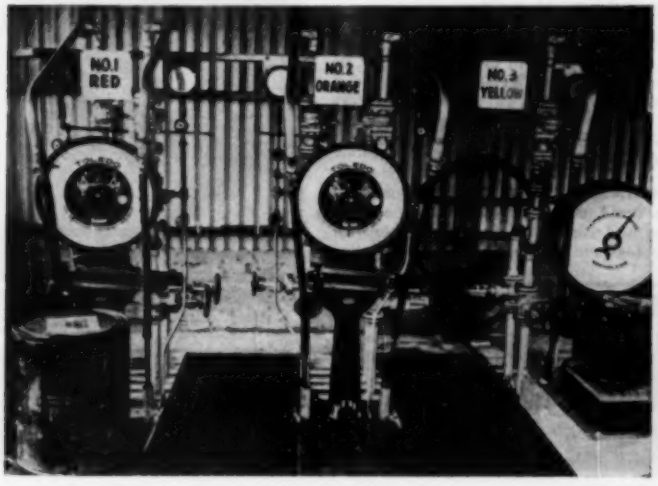
For complete details on SK Jet Eductors, request Bulletin 2-M.



Closeup of an SK Fig. 222 Jet Eductor as used in Standard Oil of California's Dye Handling System.

BULLETIN ON HEAT TRANSFER

SK Bulletin HT-1 pictures and describes standard heat exchangers, generator air coolers, feed water heaters, oil heaters, straight tube evaporators and duplex strainers. Dimensions for various sizes are included in tabular form. Copies available on request.



← **Photo shows three of the dye eductor manifolds with adjoining scales.**

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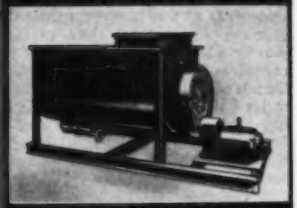
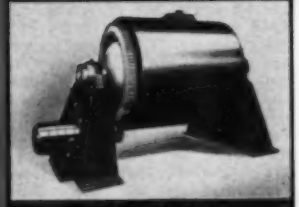
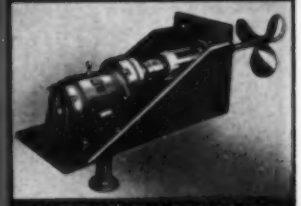


RIBBON MIXERS
From ¼ to 175 cu. ft.



BALL MILLS
Welded Steel Construction



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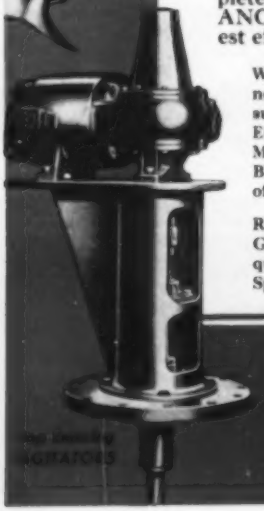


INTERNATIONAL ENGINEERING, INC.

DAYTON 1, OHIO

NEW YORK—15 Park Row CHICAGO—407 S. Dearborn

DISTRICT REPRESENTATIVES IN PRINCIPAL CITIES

Memo from the Editor John R. Callaham

New processes Foreign technology Process performance

More Information on . . .

. . . New processes & production techniques.

. . . Foreign technology & economic trends.

. . . Process performance & engineering economics.

I've learned one important thing from the reader research work we've been doing for the past few years: you want more news on recent developments in processes, production techniques and applied engineering.

From now on, *Chemical Engineering* will give you just that. It's all aimed, of course, at passing along ideas that'll help you in your jobs as engineers in the process industries.

Most of you, actually, have already noticed our trend toward more technical news. It's been evident, particularly since the first of the year, in three of our departments: Chemical Engineering News, Commodity Survey and News from Abroad.

Here's a little inside dope on what we're doing and what we plan to do with these departments.

Process News: If you'll look at our news department for this month (p. 215) you'll notice that more than half of it deals with new or improved processes and production methods. The same was true last month, will hold for coming months.

These little "process news" items aren't intended to give you exhaustive technical details on the new development. Instead, we work hard to keep them short so you can see–and see almost at a glance–what's new and unusual about the development, why it's important, what it does and how it works. In other words, its significant features in design and performance.

We've found that most of you would rather have short news items, that you know how to go back to the source for more information if you want it. So we'll try to keep them short even when we have–as we often do–reams of working material.

This month's lead-off story in our Chemical Engineering News department is on the De Nora mercury cell for making caustic and chlorine–a development you've been hearing about recently. Next month we hope –and believe–we'll be able to announce a new process (soon to be commercialized) that'll pan out to be important to the chemical industry.

And, of course, next month–and every month–we'll pass along more of those items that one reader has called "technical tips" on new processes and production methods.

Process Performance: Something new is being added to our Commodity Survey department (p. 319); more information on engineering economics and process performance.

This, too, has been in progress for many months. We've had, of course, a regular commodity survey department for several years–since the first of 1948, to be exact. It started off as a monthly economic survey on an important basic chemical commodity: trends in production, prices, uses, raw materials, supply and demand.

Now, atop these economic data, we're adding information on the processes for making the commodity: raw material factors, energy requirements, yields, fixed capital investments, materials of construction, significant operating factors. In other words, comparative process performance and engineering economics. To top it off, we'll include a simplified flowsheet of each commercial process.

Here too, as in process news, we're aiming at a broad picture of significant factors rather than one of details on operating conditions at any particular plant. This month's survey on ethyl chloride will give you an idea of what we're shooting at.

Next month's process-commodity survey will give the engineering economics of the commercial processes for making an important organic chemical.

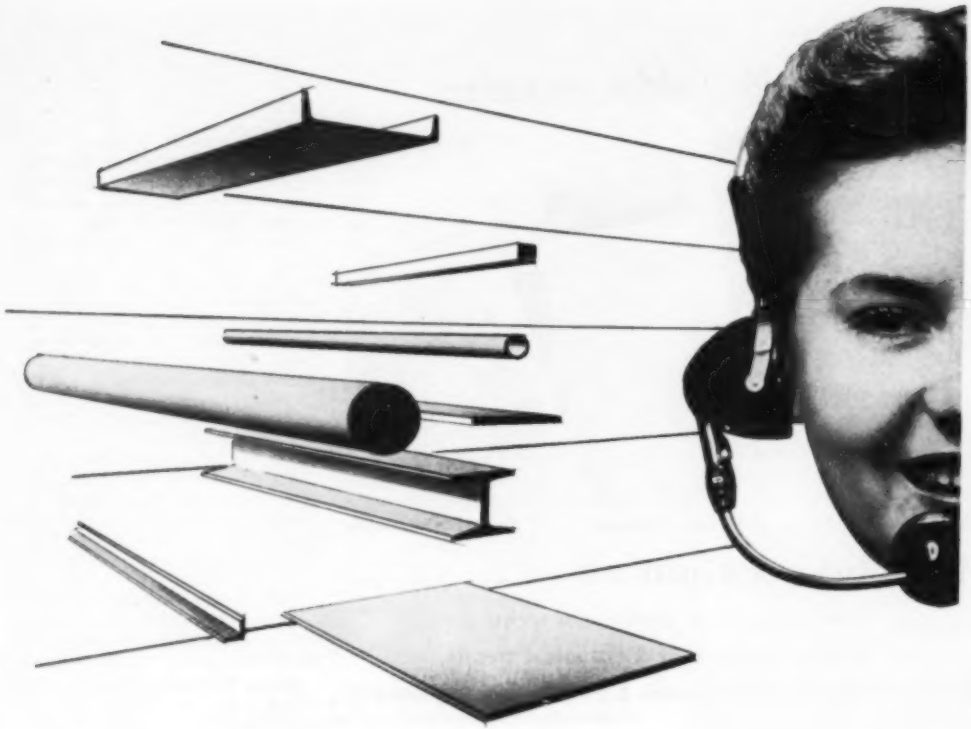
Foreign Technology: Many foreign developments, because of local economic conditions, have limited interest to chemical engineers in the United States. But many more (and the number is increasing) are of definite value to our own chemical technology.

To bring you more news on these important advances, we recently began to feature each month some major foreign development in our News from Abroad department.

This month's feature, for instance, is the new $10,000,000 ammonium sulphate unit in Mexico (p. 236). This plant is significant because (1) it is the first of its kind to get all of its raw materials from petroleum sources, (2) by making Mexico less dependent on American fertilizers and chemical raw materials, it contributes to our own economic strength. Last month's feature was a brand new development in synthetic hormones.

Our foreign technology news usually comes from one of the full-scale McGraw-Hill bureaus in London, Paris, Frankfurt, Tokyo, Rio de Janeiro, Mexico City, Bombay or Melbourne. Somtimes it originates with one of our 60 part-time correspondents spotted around the globe.

In any event, the foreign technology news that we'll continue to feature will be prepared and slanted specifically for *Chemical Engineering's* readers in American industry.



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SIDNEY D. KIRKPATRICK, Editorial Director JOHN R. CALLAHAM, Editor

Chemical Engineering

WITH CHEMICAL & METALLURGICAL ENGINEERING

MAY 1951

Confusion Confounded

Evidence is accumulating that the executive order on student deferment may have been but part of a grandiose political scheme for the military to take over both the policy and administration of selective service. By going all out in support of the very proposals General Hershey had so long opposed, someone may have anticipated the sort of inflammatory reaction that first developed in labor circles and has since spread to the halls of Congress. To pit the poor man's sons against the collegiate "aristocrats" was certain to have grassroots appeal. The big guns of the ivy league—Conant, Dodds and Griswold—added to the confusion with their persuasive argument that universal military training is the only way out. The good work of the Thomas Committee and the various scientific and engineering manpower commissions have come to nought. We drift even closer to complete military dictation of manpower policies and their administration. This we must all oppose—even if UMT should become the law of the land.

Plowing Back for Strength

Last year the chemical process industries—and manufacturing industry in general—piled up a record in net incomes. A large percentage of these gains was retained as assets.

As was expected many large industries came under fire for "making too much money and paying out too little." The lion's share of this criticism came from labor leaders, who urged that more should have been paid out in wages. But some of it came from investors who would like to see a larger portion of net income distributed in dividends.

This year the American chemical process industries plan—and hope—to spend a record $5.5 billion to expand and modernize their productive facilities. Over 90 percent of this amount (which is more than 40 percent of the planned expenditures of all manufacturing industries in this country) will come from depreciation and retained profits. The process industries have thus largely avoided an increase in indebtedness that would have been involved in borrowing.

Only now is the wisdom of management's decision becoming fully evident. For it is largely those high postwar earnings and their being plowed back into financing growth that our industry today is in such condition—physically and financially—to meet the demands of the national defense program and at the same time maintain a high output of civilian goods.

Management's policy of plowing back last year's profits is bringing about today's strength and tomorrow's security.

What Role for the Reservists?

Recent studies by the Manufacturing Chemists' Association and others have shown that approximately 25 percent of the technological personnel of our industry is in reserve status. Even more of the chemists and engineers in the age bracket between 25 and 33 years have either served with the armed forces or had ROTC or other training. In the event of all-out war, the demand for military services might logically take precedence over most of their jobs in industry. But the situation today is quite different and far more critical than most people realize.

The pressure is now on industry to produce superior weapons and equipment, ammunition and supplies absolutely essential to our national security. We are in transition to an arsenal economy in which we need all of our technological resources—all of the scientific creativity and engineering productivity we can quickly marshal to the defense program. To deprive industry now of the services of many of these young technologists will severely handicap if not defeat our remobilization effort.

Few outside the ranks of the chemical and process industries realize how much responsibility centers in the ranks of the reservists. Many of these young technical men are just now emerging as key specialists in research, engineering design and production. Some have had as many as six or eight years of intensive training for their specific responsibilities. They cannot be replaced by inexperienced personnel, even assuming such men were now available.

Because this problem vitally affects our whole

economy, concerted action is being urged by all of our scientific and engineering societies. At its recent meeting in Cleveland, the directors and council of ACS went on record urging the Department of Defense to set up a committee to aid in reviewing all appeals for deferment on the part of reservists engaged in scientific and technological work. No phase of the manpower problem is more acute. Unless intelligent action is taken soon, the chemical industry will suffer irreparable damage to its defense program.

A Tremendous New Customer

Agriculture is going to buy more chemicals for pest control than chemical makers have even dreamed of selling up to now. In many cases demands currently forecastable seem likely to take from five to twenty times any previous tonnage so used. In fact some exceed the entire output of existing plants.

If these forecasts came from irresponsible sources, we would not take too much stock in them. Certainly we would not be writing here about them. But they come from the Chief of the Bureau of Plant Industry of the U. S. Department of Agriculture in an address given before National Agricultural Chemicals Association during April. Thus they clearly do deserve comment. Even more, they deserve analysis and thoughtful consideration by thousands of chemical makers.

Many divisions of both inorganic and organic chemical manufacture are going to be affected. The demand will be for everything from chlorine, benzene, and caustic soda, up to the more complex organic and inorganic compounds. The job ahead is a tremendous one, which is none too welcome just now when defense needs are so burdensome.

But this is certainly a demand which cannot be ignored. These chemicals for pest control are essentially labor-saving materials. Their adequate use also determines the adequacy of food and fiber supply. None of us can afford not to read what Bob Salter said, nor dare we ignore the general forecast which he gives us.

Everybody's Business

Pollution of air and streams has become an extremely serious problem in the United States—and the enormous industrial expansion brought about by defense is not easing the situation. This is not merely a matter of spoiling bathing beaches—or even of disasters such as the Donora cataclysm. It is a matter of good, hard economics. We *must* conserve our water supplies and clean up the atmosphere if we are to maintain and improve our high standards of living.

Industry is not solely to blame for many of the deplorable conditions that exist. Still, the fact remains that in many cases industrial plants—and process plants in particular—are major polluters of streams and air. It is true too that many are not yet doing what they can to improve the situation. As one item of evidence, take the recent comprehensive survey by U. S. Public Health Service of the Tennessee River Drainage Basin. There only 43 percent of the process plants in the area have facilities for controlling stream pollution. And of these, only a half are adequately operated and only a third have adequate capacity.

Before long this means that a big, essential job must be done. It will not be a job for sanitary engineers and industrial hygienists alone, but for everybody in process industries. Because it is everybody's business we have attempted in this month's *Chemical Engineering* report, which starts on the following page, to put the problem, its causes, and some of its solutions on a sound and scientific basis.

Avoiding Human Obsolescence

Few industries are more progressive than petroleum when it comes to modernizing its processes and equipment. Lately some of its leaders have begun to realize that technical personnel which does not keep in close touch with new developments may also become obsolescent. To do something about it Humble Oil and Refining Co. has set up its own classrooms to provide on-the-job training for its research engineers and technologists.

Two types of classes are held. The first is an advanced 10-week course in chemical engineering given primarily for new employees. It shows the students how chemical engineering principles can be applied to oil refining and also serves as a refresher course for the older chemical engineers. Instructors are selected from Humble's technical staff largely under the direction of H. Dayton Wilde, Manager of Research and Development.

The second type of training is a series of two-week courses taught by top-flight professors of science and engineering. Each course is about the equivalent of a semester of graduate training at a university and covers the particular specialty of the professor. For example, its roster has included such chemical engineering educators as Colburn on distillation, Dodge on thermodynamics, Gilliland on process development, Hougen on applied kinetics, Pigford on chemical engineering mathematics, and Rushton on mixing. Classes are carefully selected from those who volunteer for the courses and are willing to devote full time to study, preparation of reports and competitive examinations.

According to Dayton Wilde the over-all costs of the lecture courses to the Humble company have ranged from $25,000 to $35,000 per year. These sums are small indeed compared with the millions spent for modernization and replacement of physical facilities. Yet they have already proved an excellent investment in preventing obsolescence of human facilities by stimulating technical employees to grow and develop in their jobs.

This Dorr installation for treating industrial waste uses pre-digestion, biofiltration, and slow sand filters.

POLLUTION CONTROL

Population growth and industry expansion are bringing us close to a pollution control crisis in many areas. While water shortages threaten, pollution is adding to the expense and difficulty of treatment. Air pollution, though harder to assess dollarwise, still causes great loss and is important psychologically.

CHEMICAL ENGINEERING REPORT—MAY 1951

ALTHOUGH industry shares responsibility with the public for the pollution of streams and atmosphere, there is a great deal that industry can and must do to control the disposal of its wastes. Occasionally this means the possibility of recovery of a profit hitherto escaping as a waste. More often the control of pollution is necessarily a part of the cost of production which companies must bear as good members of the community. In so doing they ease their own problems of supply of clean water and unpolluted air, they gain the reputation of being "a good place to work," and a good neighbor, and they avoid legal liabilities which at best are still ill-defined in the law.

Legal aspects unclear

Legal compulsions to pollution control remain hazy in many respects, but are becoming better defined. The Federal Water Pollution Control Act, having no teeth of its own, is still both a weapon and an encouragement in the hands of state and local authorities. Not yet on the books, it is inevitable that there will be a similar air pollution act within a few years. Meanwhile, although the defense effort may produce some relaxation in the attitude of authorities who appreciate the difficulty of securing equipment, this relaxation will be both temporary and probably limited to non-defense areas.

Process industries' part

Process industries have an enormously important part in this pollution control job, a fact of which they are thoroughly aware. As evidence of this awareness we point to the many pollution control symposiums that have been held during the past two years, and are still being held. Unfortunately for the average chemical engineer, most of the papers have been aimed at the pollution control specialist, which tends to obscure the fact that pollution control is everybody's business. Our purpose here is different, and our reason for adding another symposium to the long list is to bring the problem home to those who are not specialists.

To that end this 48-page *Chemical Engineering* Report offers a group of 12 articles in three parcels: a general introduction, the water pollution problem, and the air pollution problem. The introductory article answers the question of WHY. In both the water pollution and air pollution sections one article opens the subject by showing WHAT the problem is, while the remaining articles answer the question of HOW pollution can be controlled.

Pollution Control—an Industry Must

Stream and air pollution is a growing problem—not all the fault of industry, but still in part industry's responsibility.

MELVIN NORD, Wayne University, Detroit, Mich.

Pollution of air and streams by industry is by no means a new problem, but it is one that is growing at an ever accelerating pace. Evidence of this appears abundantly in the smog faced almost daily by city-dwellers. It appears in recent governmental regulations relating to air and water pollution, in newspaper accounts which report on progress in the abatement of pollution, and in the technical and trade literature. Finally, it is evidenced in the uncomfortable position in which many industrial companies are now being placed by the public or by governmental agencies.

Pollution becoming normal

Air and stream pollution problems have multiplied in recent years because of the growth of population—particularly in cities—and because of the remarkable expansion of industry which has occurred within the past ten years. In many localities the point has been reached where the atmosphere and bodies of water do not act like the "infinite diluents" we commonly suppose them to be, so that polluted air and streams are the normal, rather than the abnormal, condition. The capacity of the atmosphere and of many streams to receive the waste discharges of industrial and domestic establishments has been seriously impaired by the congestion in urban centers. Whereas a plant may once have been at the outskirts of a town where complaints would not arise, the same plant may now be virtually surrounded by a residential district. These changes have been proceeding continuously over a period of time, and now have reached the critical stage where vigorous corrective action is an absolute necessity.

Pollution scares the public

The direct effects of pollution on the public include interference with public health, welfare, and property. An indirect, though very important effect on the public is the feeling of uncertainty and anxiety inherent in pollution. The emotional state of the public has been characterized as bordering on mass hysteria.[1] Those in industry who have had to face indignant and over-excited neighbors who are susceptible to the feeling that they are "choking to death"—generally about midnight—and who are going to see that you are run out of town, realize that the imaginary problems of air pollution are as serious to industry as the bona fide pollution problems. When pollution of the air or bodies of water becomes intolerable, industry finds itself engaged in technical-legal discussions with plant superintendents, attorneys, and governmental control agents. In addition, it soon becomes apparent that industry's own water supply problems have become more serious, and that the cost of treating water for industrial purposes has increased.

While pollution is not caused solely by industry, it is true that industry is responsible for a large share—perhaps half the total. In the case of stream pollution, it has been estimated that there are 20,000 sources of pollution in the country, about equally divided between domestic and industrial wastes. It is estimated that it will require more than $8 billion to construct the necessary treatment facilities to cope with these problems.[2] Obviously a problem of such magnitude will not be corrected within a year or two.

Technology is lagging

The problem thus posed, the abatement of air and stream pollution, is one which has many facets. From one standpoint it appears to be purely a technological problem. Unfortunately, however, our knowledge of pollution and the technological means of controlling it have not kept pace with the problem itself. This is because prevention of pollution is rarely a profit-making enterprise. Furthermore, what knowledge there is on the subject is not generally widespread. Companies faced with pollution abatement problems often find that they have no one on their staffs familiar with the problem, and certainly no one as expert in this field as they are accustomed to finding in their principal business.

It is an easy, but dangerous, oversimplification to adopt the view that pollution control is entirely a technological problem. This is the view that the public and the pollution control agents take when they wish to show how absurdly easy it is to "stop" pollution. The statement of the Chief of the United States Public Health Service is typical of this viewpoint: "It is inconceivable that the technicians who have developed American industry to its predominant position should confess defeat on such a relatively minor problem. Actually, wherever there is a desire to eliminate harmful results of wastes, technicians can find a way."[3]

On the Problem

"In many localities the point has been reached where the atmosphere and bodies of water do not act like the 'infinite diluents' we commonly suppose them to be, so that polluted air and streams are the normal, rather than the abnormal condition."

"Whereas a plant may once have been on the outskirts of a town where complaints would not arise, the same plant may now be virtually surrounded by a residential district."

Economics involved, costs up

The problem of pollution abatement is not purely a technical one, but involves other factors, such as economics. While pollution can

certainly be reduced, some reasonable limit to the degree of contamination must be established in any particular case. Involved in the question of reasonableness is the question of cost. Industry is directly concerned with the cost of pollution abatement, and the public is indirectly involved through the increased price of commodities. In addition, the public is directly concerned with the cost of municipal sewage and waste treatment, because it must pay the taxes. The past few years has seen an unprecedented increase—as much as four- or five-fold—in these costs.[28] It should be kept in mind that municipalities are subject to state statutes regulating pollution, and indeed are often among the worst offenders.

Public and the law

In addition to technical and economic questions, pollution abatement also involves much more complicated and difficult problems—human problems. These include the physical and psychological reactions of the public. Public relations represents a very important factor which is likely to be mishandled by the company. Finally, there are the legal aspects of pollution control, which may become of crucial importance to the life of the business itself when the other phases of the problem have gotten out of hand.

PUBLIC HEALTH ASPECTS

Regarding industrial air and water pollutants as "industrial poisons," it should be noted that there are three main channels through which such substances may enter the human body. These are (1) breathing into the respiratory tract (as dust, fumes, mists, or gases), (2) swallowing with saliva or water into the digestive tract, and (3) absorption through the skin.[30] Each of these methods may occur when the atmosphere is polluted, while the second and third methods may occur in the case of water pollution.

Toxic substances which may be discharged in industrial waters include a wide variety of organic compounds, as well as some inorganic substances such as lead, arsenic, fluorides, chromium, and copper. Certain industrial effluents, such as those from processes which involve the treatment of vegetable or animal materials, may also contain bacteria in large numbers. Furthermore, the discharge to a surface water of any type of decomposable organic matter will result in an increase in the number of bacteria present in the water.[29]

Adds to treatment load

Nevertheless, despite these facts, it may be said generally that the health hazards caused by polluted water are less important than its other effects. Toxic substances in water may obviously affect people who drink such water, but municipal treatment methods remove most of the dangers. The presence of industrial wastes increases the load on municipal water-treatment plants, so that the effect becomes an economic one, rather than a health hazard. The poisoning of fish and farm animals by metallic poisons, alkalis, and other toxic substances in streams is also an economic effect of stream pollution.

It is true that typhoid fever and some other diseases may be water-borne[4], but the organisms responsible for such diseases rarely occur in industrial wastes; they come instead from inadequately treated domestic sewage. The possibility of adversely affecting public health by water pollution at bathing beaches is a real one, although there is apparently little or no evidence to indicate that such adverse effects are in fact realized.[29] However, bathing beaches can certainly be ruined as recreational sites by unsightly appearance or unpleasant odors in the water. It is also possible that odors present in streams may have adverse effects on the comfort of neighbors. This is particularly the case where oil may be trapped in rushes.

Health hazards of air pollution are of much greater importance than those of stream pollution, although they have often been grossly exaggerated.[5, 6] In contrast to water pollution, where domestic wastes constitute a greater health hazard than industrial wastes, the reverse situation holds for air pollution. Although most air pollution is due to smoke from both domestic and industrial sources, the physiological factors in air pollution are mostly derived from industry.

Air-borne pollution hazards

Air-borne contaminants may have the following effects on the body:[30]

1. They may cause skin irritation or affect the mucous membranes of the respiratory tract and eyes. This is true of acid vapors and certain caustic compounds which are easily distributed in the air.

2. They may enter the lungs or be absorbed by the blood stream and produce systemic poisoning. Examples of this type are benzene vapors and lead fumes or dust. These substances may produce deleterious effects when the exposure is severe or prolonged.

3. They may produce asphyxia, by affecting the respiratory center or the nerve endings in the lungs, causing a cessation of breathing. Such poisons include HCN and H_2S. In the case of CO, the gas may combine with the

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hemoglobin of the blood so that oxygen cannot be furnished the tissues.

4. Certain dusts, including silica, granite, and asbestos, may cause fibrosis of the lung tissue which predisposes to tuberculosis.

Synergism a factor?

These various effects of air-borne contaminants have been found primarily in the studies of industrial hygienists, who were concerned with air in factories, where exposures to high concentrations are possible. Much less is known of the effects of lower concentrations of these contaminants, such as might be found in the atmosphere of industrial regions. It is known, for example, that acute poisoning from carbon tetrachloride vapors does not result with less exposure than half an hour at a concentration of 1,000 ppm. Continuous exposure in a factory to a concentration of 100 ppm. will cause serious physiological disturbances.[10] This does not, however, mean that a concentration below 100 ppm. in the atmosphere is necessarily a "safe" concentration. It must be kept in mind that exposures in factories, which have been used to determine safe limits in industrial hygiene, are generally over 8-hr. periods for five days per week. The neighboring populace is exposed 24 hr. per day, and seven days per week. In addition, concentrations which are "safe" for the healthy workers in a factory may not be safe for children, aged or ill people. There is also some evidence to indicate the existence of a synergistic effect in air pollution, whereby exposure to several contaminants simultaneously may have an effect that is greater than the sum of the individual effects.

Case vs. air pollution

The case against air pollution as a health hazard includes the following principal points:

1. Respiratory Diseases—Mortality rates of children under five years of age from bronchitis and pneumonia in England follow the zone of industrial activity. Deaths from respiratory diseases increased from 2.1 to 13.9 per 1,000 during a series of bad fogs in 1909 in Glasgow. In the cities of Manchester and Salford, England, there were 137 deaths in Dec. 1930 when there were no fogs, and 592 deaths in Jan. 1931, during which month there were nine days of fog.[4] Another correlation of deaths from respiratory disease, with smoke fog in neighboring communities in England, indicates the following results for a two-week fog:[10]

Community	Hours of Sunshine	Deaths From Respiratory Disease
Leeds	2	135
Harrogate	30	10
Ilkley	23¼	2

It has been suggested that the irritation of the respiratory tract caused by atmospheric contaminants is less likely to cause tuberculosis than it is to increase the distress of those suffering from this disease or those who are prone to bronchial disorders and asthma.[10a] On the other hand, there is as yet no proof that any industrial contaminants other than silica and iodides can accelerate or aggravate tuberculosis.[10] In America, correlations between deaths from pneumonia and intensity of sootfall have been advanced. In fact, the statement has been made by a member of the medical profession that "smoke is without doubt the most important factor contributing to the high pneumonia mortality rate in industrial cities."[11] A relation between cancer and coal tar has also been suggested by many workers.[4] At the U. S. Technical Conference on Air Pollution held in Washington, D. C., in May 1950, it was concluded that "the pollution of the atmosphere with allergenic material of industrial origin is associated with a frequent, and apparently increasing, occurrence of acute and chronic disease, involving especially the respiratory tract and the skin."[12]

Eyes are vulnerable

2. Effect of Air-borne Contaminants on the Eyes—The best example of eye irritation caused by air pollution is found at the present time as a continuing effect in the Los Angeles area. The best evidence now available indicates that no single substance is responsible for the eye irritation, but that it is rather caused by the combined effect of a number of contaminants. At least nine substances capable of producing eye irritation have been found in Los Angeles air. None of these is present in sufficient quantity to cause eye irritation by itself. It has been shown, however, that the combined effect is capable of producing eye irritation. Among the contaminants found are formaldehyde, ammonia, sulphur dioxide, nitrogen oxides, acrolein, ozone, carbon and oil.[13]

3. Loss of Ultraviolet Rays of the Sun—In addition to irritant and toxic effects of air pollution, it is also evident that considerable loss of sunshine results. If the loss of ultraviolet rays is sufficient, it may be a contributing factor in the production of rickets and other deficiency diseases. Sunshine is a vital element in the maintenance of health and the promotion of growth, as is indicated by its value in the treatment of certain diseases and in the recovery of health after an illness.

On Public Attitude

"Those in industry who have had to face indignant and over-excited neighbors who are susceptible to the feeling that they are 'choking to death'—generally about midnight—and are going to see that you are run out of town, realize that the imaginary problems of air pollution are as serious to industry as the bona fide pollution problems."

"It is important for the public to realize that industry is not its enemy; that instead, it is the provider to jobs, commodities, and tax income for the local government."

Odors appear harmless

4. Effect of Odors on Health—"The age-old belief that odors themselves cause disease still needs to be dispelled. It is true that offensive odors may interfere with proper sleep, proper intake of food and water, may excite emotional nausea and vomiting but, in themselves, are otherwise unimportant to health except that some odor vectors . . . may serve as allergens."[10]

At the present time there is little direct evidence to show whether the general air pol-

lution of cities has any adverse effect on city-dwellers. However, it is, well known that such adverse effects may exist near factories emitting toxic substances, especially under abnormal meteorological conditions.

In the Meuse

In the Meuse valley in Belgium, between December 1 and 5, 1930, a thick fog covered the area. As a result, many people were injured, 63 people died, and many head of cattle had to be destroyed. When the fog lifted, the respiratory troubles improved and rapidly ceased. The incident occurred because of an unusual condition of temperature inversion which prevented upward motion of the smoke-laden air, together with the fact that the area is located in a valley. The combination of meteorological and geographical factors produced in effect a tight ceiling over the area into which smoke continued to pour but from which it could not escape. It was concluded that the principal contaminant responsible was SO_2 from the combustion of coal, although nearly 30 toxic contaminants were found in the air.[3] The conclusion of the investigators of this tragedy was ". . . the conjunction during more than three days of the same exceptional meteorological conditions would cause the same accidents. . . ."

On Health

"Although it has been stated many times that the health of people of cities and industrial areas is adversely affected by the common air pollutants, this has never been demonstrated in the form of authenticated chronic disease processes. . . . In view of the fact that tobaccco smoking—which is a highly intense form of personalized air pollution—is not regarded as harmful for most people, it seems doubtful whether the general contaminants in ordinary city air have any perceptible effect on the health of urban dwellers."

. . . and at Donora

Unfortunately, this prediction was verified during 1948 in the Donora, Pa., disaster. There a similar set of meteorological and geographical factors combined to cause 500 illnesses and 19 deaths in a population of 14,000 people. In Los Angeles, unusual meteorological conditions also contribute largely to the air pollution problem. A temperature inversion layer commonly exists in this region, but it is fortunately sealed only on one side by mountains. In Nov. 1950, an air pollution disaster occurred in Poza Rica, Mexico, in which 320 people were hospitalized and 21 died within a period of two days. Remarkably enough, none of the several hundred workers in the plant were injured. A heavy fog, combined with a temperature inversion and the presence of the nearby refinery emitting gas containing large amounts of H_2S, caused this disaster.[3]

Although it has been stated many times that the health of the people of cities and industrial areas is adversely affected by the common air pollutants, "this has never been demonstrated in the form of authenticated chronic disease processes."[34] "The day-by-day, little-by-little injury, if any exists, is scarcely measurable."[35] In view of the fact that tobacco smoking—which is a highly intense form of personalized air pollution—is not regarded as harmful for most people, it seems doubtful whether the general contaminants in ordinary city air have any perceptible effect on the health of urban dwellers.

ECONOMIC ASPECTS—STREAMS

Losses caused by stream pollution include:

1. Increase in Cost of Municipal Water Treatment—Nearly all forms of pollution increase the difficulty and cost of municipal water treatment. The removal of toxic substances may require unusual methods of treatment. In addition, certain toxic substances interfere with the biological purification processes commonly employed in municipal water-treating plants. Substances which cause taste and odor also require special treatment. Although phenol is in itself not so bad in this respect, chlorophenols are formed when the water is chlorinated, which cause taste and odor at much lower concentrations (approximately 1 part per billion). Substances which cause turbidity or deposit solids increase the loads on primary treating units and may interfere with flow, pumping, measurement, etc.[5] Substances which increase the biochemical oxidation demand (B.O.D.) increase the load on both primary and secondary treating units. Corrosive chemicals may have a destructive action on the treating equipment. Substances which cause color (such as organic dyes) also may require unusual methods of treatment. In some cases it is necessary for a city to extend its water intakes a long way to avoid taking in polluted water.

2. Increase in Cost of Industrial Water Treatment—Water used in industry for cooling purposes may prove to be corrosive or scale-forming, if it is polluted. Boiler feedwater that is not properly purified of contaminants may cause the formation of thick, adherent scale deposits, or may cause corrosion, caustic embrittlement, foaming, and priming. Water for chemical processes may be unsuitable because of the presence of hardness, minerals such as iron, color, suspended materials, carbon dioxide, acidity or alkalinity, organic matter, and bacteria. Water for use in food industries presents problems similar to those in municipal water treatment.[36]

Water treatment costs

3. Other Direct Economic Effects—Polluted water may in some cases cause poisoning of farm animals, and may interfere with other agricultural activities, including irrigation and the use of water in dairies. In addition, polluted waters may cause soil erosion, if the bank and shoal vegetation is destroyed.[5] Polluted water may cause the destruction of fish, owing to the presence of toxic substances or reduced concentration of dissolved oxygen in the water.[37] Recreational properties and activities, such as bathing and fishing, are also adversely affected by stream pollution. Another important economic effect of stream pollution is its interference with navigation. Thus, acidity causes corrosion of steelwork, including craft and shore installations. The deposition of banks

of mud which must be removed by dredging is an economic effect of pollution on navigation.

Control an overhead cost

4. Indirect Economic Effects on Industry—As a result of regulations forbidding the discharge of contaminated effluents into streams or into municipal sewer systems, many important plant problems arise. For example, a centralized cooling water system may not be economical when the only consideration is a saving of material which would otherwise be discharged. However, when the cost of treating the waste coolant to conform with water pollution regulations is considered, it may be found that the installation is well worth the investment. Pollution problems may in some instances be the limiting factor in plant location. In the design of a new plant, provision must be made for the installation of collecting mains, since it is obviously much more expensive to add them later as an afterthought. Although it is sometimes possible to recover valuable materials in waste treatment, the opposite is generally the case. It is therefore necessary, in most instances, for plant management to reconcile itself to the necessity of including a sufficient item of overhead to take care of waste disposal'. Not to be overlooked also is the fact that damage suits or an injunction may be an economic consequence of pollution.

ECONOMIC EFFECTS—AIR

The economic effects of air pollution are of enormous magnitude. Estimates of the "cost" of air pollution in England have been made at £90 million a year, [10] and in the United States at $1½ billion per year.[9] It has been estimated that the damage to, and increased maintenance costs of, buildings, clothing, furnishings, etc., in St. Louis before 1940 came to $14 million annually. The economic loss from incomplete combustion (which is a principal factor in the production of smoke) is perhaps 15 percent of the total "cost" of smoke. There is evidence to indicate that the cost of eliminating excessive air pollution would in many cases be more than made up in the aggregate by the savings in property damage and maintenance. At present, industry is spending $200-300 million per year on the control of air and water pollution.

On Economics

"The economic effects of air pollution are enormous. Estimates of the 'cost' of air pollution in England have been made at £90 million a year, and in the United States at $1½ billion per year."

Pollution affects vegetation

In addition to its effect on inanimate property, the effect of air pollution on animals and on vegetation must also be considered. The direct effect on animals is not ordinarily of much importance, but the indirect effect on certain kinds—such as cattle—from eating contaminated vegetation is sometimes very serious. The effect of air pollution on vegetation has proved to be extremely troublesome—especially to industry by way of lawsuits. Air pollution adversely affects plant life in four principal ways: (1) Reduction in the amount of sunlight interferes with the vital process of photosynthesis. This reduction is caused by smoke or fog in the atmosphere and by soot deposits on the leaves of plants. (2) Deposition of soot on leaf surfaces tends to choke the minute openings (stomata) through which respiration is conducted. (3) Plants are affected by sulphur acids contained in the deposits on the leaves, causing damage to living cells and the destruction of chlorophyll. (4) One of the most serious of all the adverse effects on plants is caused by the deposition of sulphuric acid in the soil. The resulting acidification of the soil reduces the work of soil bacteria, particularly those responsible for the production of nitrates.

Sulphur killed forests

The most serious air pollution lawsuits have been occasioned primarily by the action of sulphur acids from smelter smoke on vegetation. In Ducktown, Tenn., two copper smelters issued forth large amounts of SO_2 (from the roasting of copper sulphide ores), leaving a barren trail for 30 miles through the forests of Georgia and across the state border line. After the United States Supreme Court (in an action by the State of Georgia) enjoined the smelters from continuing the nuisance, apparatus was introduced to recover the SO_2. The result was a remarkable industrial achievement: the adaptation of the lead chamber process of producing sulphuric acid from smelter smoke. Later, the manufacture of sulphuric acid became the principal business, with copper ranking as a byproduct.

Again, in Salt Lake City, for the first 20 years of the century, a bitter controversy continued as a result of the operation of four smelters. The region contained many small farms and pasture lands, which were very sensitive to SO_2. As a result, two of the smelters discontinued operations, while the other two were required by a federal court to control their stack emission in certain specific ways and to treat the gases for removal of mist and solid particles. In Trail, British Columbia, a few miles north of the international boundary, a zinc-lead smelter emitted 600 tons per day of SO_2, causing injury to crops and forests in the state of Washington. As a result of complaints, a large and diversified chemical byproduct plant was erected to make sulphuric acid, ammonia, phosphates, fertilizers, etc. In addition, damage claims of $78,000 were imposed on the company.[11]

Arsenic poisoned cattle

In Anaconda, Mont., arsenic contained in smelter smoke caused heavy losses of vegetation and of livestock including horses, cows, and sheep feeding on hay and range grasses. As a result, the smelter plant was dismantled and a new one built, utilizing electrostatic precipitators as collecting means. Later, the top soil of a large area adjacent to the old site was stripped off, concentrated, and smelted at the new plant, with a recovery of over a million dollars in copper and other metals.[11]

The cases cited above are unusual, in that they constitute cases where it was economical to recover contaminants from air emissions. This is rarely the case. In general, air pollution

control must be regarded as a necessary item of overhead expense. If such control is inadequate, damage claims or an injunction may result, or in some cases it may be necessary to buy the land of the complainants at an exorbitant price.

PUBLIC RELATION ASPECTS

It is important for management to realize that pollution is not entirely a technical problem, but one which involves people. As such, industry cannot expect as a matter of course that events will follow a "logical" pattern. Actually, phychology, i.e. "public relations," plays an important part in pollution problems.

Public needs education

Industry must first realize that the public is insufficiently "educated" on the facts of pollution to be in a position to weigh a given situation objectively. Because of the public's inability to distinguish between the health aspects of pollution and those relating solely to its comfort or to economic matters, and because of the widespread publicity on the subject of pollution, the public is easily panicked. This state of anxiety and fear needs to be dispelled by giving the public a more realistic picture of pollution problems. The public must first come to realize that industrial areas will always be contaminated to some extent, unless industry is evicted. All that can reasonably be expected on the part of industry is a reduction in pollution to a tolerable level. It is important for the public to realize that industry is not its enemy; that instead, it is a provider of jobs, commodities, and tax income for the local government.[5] The public must also be made to realize that the control of pollution takes time. Apart from economic and technical problems, time is required to design, construct, and install new controls. The public must learn to substitute patience for hysteria. This will not happen, however, unless industry keeps in mind the "human" side of pollution problems."

It is important for industry to develop a better public relations policy in this regard. It should be obvious that in public relations, silence is not golden. When a company is accused of causing air or stream pollution and it maintains a studied silence, it appears to the complainants that the company management is indifferent. Actually, in many cases of this type, management is very concerned indeed, and even worried to the extent that it has sought advice counsel. Lawyers naturally regard pollution as entirely a legal problem, so that they ordinarily advise the client neither to admit nor deny anything, but to remain silent while considering the matter further. The fury of a public which thinks it is getting the cold shoulder in such a case may reach the stage of a holy crusade with the object of running the company out of town.

How not to answer complaints

When management is accused of causing pollution, it is very likely to set up a defense in depth which consists of the following tactics: (1) First the company denies that it is committing any such nuisance—stating in no uncertain terms that there is no possible way in which it could cause pollution, that there is no such pollution except as a figment of somebody's imagination, and that furthermore if there is any pollution, someone else is doing it. (2) After this tactic fails to have the desired effect, management is next likely to observe somewhat philosophically that after all, you can't expect to have the air and water in an industrial area as pure as those at a summer resort—and that, furthermore, everyone else is getting away with it. (3) When this tactic also fails to produce the desired effect, a legal silence sets in and the war is on.[5] In most cases, tactics such as these are not planned in advance to have a certain effect, but happen because of industry's inability to see the public's side of the question. Even when the public is completely wrong in its accusations—which unfortunately it is a considerable portion of the time—industry should adopt a cooperative attitude, rather than a pugnacious or legal attitude. It should realize that once the public is convinced that a certain company is its enemy, then the people cannot be unconvinced until a thorough survey of the community's pollution problems has been made and steps have been taken to correct them, whoever is at fault.

On Public Relations

"It should be obvious that in public relations silence is not golden. When a company is accused of causing air or stream pollution and it maintains a studied silence, it appears to the complainants that the company management is indifferent . . . The fury of a public which thinks it is getting the cold shoulder in such a case may reach the stage of a holy crusade with the object of running the company out of town."

Agents are reasonable

Included in the "public relations" activities of a company is its attitude toward governmental pollution control agents. It cannot be overemphasized that the overwhelming majority of these agents are not out to "get" any company. Their only concern is to stop pollution—not to put you out of business. As one of them has said, "Our aim is to impel, not compel, cooperation." If industry adopts a cooperative spirit towards these agencies, it will find that they will act reasonably. Unfortunately, there are some rare exceptions to these generalizations, particularly in cases where the agent is a political appointee, not a technical expert.

LEGAL ASPECTS

Because of the crucial importance of the legal aspects of air and stream pollution, it is difficult to convey a sufficiently detailed picture of the situation in a short space. More details can be found in other articles of the author."

What is a nuisance?

In general, legal liability at common law for air pollution is based on the ground of nuisance. A nuisance is defined as an unreasonable interference with the right of an occupier of land to make such use of it as he pleases. What is unreasonable is for the court to decide. Liability for a nuisance does not require intent to harm or even negligence; strict liability results from the performance of the act. If the nuisance affects only a private person, it is a

private nuisance, for which a private action for damages or an injunction can be brought by the aggrieved party. If the nuisance tends to affect people generally, it is a public nuisance, which is indictable as a minor crime. Contrary to general belief, the act need not be a continuing one in order to constitute a nuisance; however if it is a single act an injunction will not ordinarily be given. It is also important to realize that an act need not constitute a menace to health to be a nuisance. If it interferes substantially with the comfort of the (normal) individual or with his use of his property, it constitutes a nuisance. The fact that a once remote area has now become residential is no excuse for the continuation of a nuisance, nor is it an excuse that others are doing the same thing. There is a conflict of authority among the states as to whether an injunction against a business will be given, when to do so would cause a disproportionate injury to the defendant as compared to the injury being suffered by the plaintiff. However, damages will always be granted in such a case.

The common law

Common law liability for stream pollution may be predicated either on the ground of nuisance or on riparian rights. A riparian owner is one who occupies land adjoining a watercourse. As such he has the right to receive water from upstream riparian owners in an unpolluted form. Depending on the state involved, the law differs as to the strictness of the standards imposed.

In the case of both air and stream pollution, legislation has been used to supplement the common law. This legislation has been found necessary in order to control air and stream pollution because: (1) It is generally difficult for the public to discover and to prove pollution. (2) In many cases, pollution is so widespread that it could not be stopped by only a few lawsuits. (3) In some cases of widespread pollution, it would be difficult to establish the existence of a nuisance caused by a single company. Such legislation is not based necessarily on the nuisance doctrine, but is based on the broader doctrine of "police power," i.e., the right of the state to make laws for the protection of public health, safety, and welfare. It should be emphasized that this legislation does not supplant the common law. Thus, even if you satisfy the pollution control agency, you may still be subjected to successful lawsuits by private individuals.

New federal statute

A federal stream pollution statute was passed in 1948. This act is administered by the Public Health Service. It does not directly affect liability for stream pollution, but provides monetary aid for state enforcement agencies and loans to industries and municipalities for the construction of stream pollution control plants. The Federal Government has no police power; the statute is instead based on the power of Congress to regulate interstate commerce. This power extends only to navigable streams.

Air pollution legislation has, in general, taken the form of municipal ordinances. These are generally similar in nature. They are directed principally against smoke, and set up a Smoke Prevention Bureau, with power to control other types of air pollution also. Stream pollution legislation is generally in the form of a state statute, setting up the necessary administrative agency. In some cases, water pollution ordinances are in effect which prohibit the discharge of certain contaminants in specific concentrations into municipal sewers. As a rule, an administrative agency may give a cease-and-desist order, prohibiting the continuation of pollution practices. This can be enforced by a court action in which an injunction is obtained. Courts customarily rely very heavily on the findings of fact of the administrative agency. For this reason, it is necessary to defend oneself before the agency, rather than to rely on doing so later on in court.

Although there have been a number of bills introduced in Congress, no federal air pollution statute has yet been passed.

Vagueness a problem

In most cases, legislation is not very specific as to exactly what constitutes pollution. This is generally very annoying to a company accused of polluting air or a stream. On the other hand, if rigid standards are adopted they are often arbitrary and hence either unworkable or unjust. It is unwise to permit the slide rule and the handbook to replace critical appraisal and judgment in pollution cases, since they differ enormously in different localities. It would unnecessarily hamper the activities of pollution control agencies if they were to be deprived by the legislature of the opportunity of exercising any discretion. This problem is one which occurs throughout all branches of the law. If the law is too vague, it is difficult to know how to comply with it. On the other hand, if the law is too rigidly specified, it may be violated more easily and in addition may work hardships in many cases.

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Size up Your Liquid Waste Problem

Here is defined the character of industrial wastes. The author recommends patient study of all angles of the disposal problem.

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Liquid wastes from process industries are of concern as stream pollutants when their content of objectionable components exceeds certain allowable limits. Industry is accustomed to consider losses of a few tenths of one percent of solids, metals, or organic matter as indicating efficient operating conditions. Sanitary engineers and chemists, however, are working in a field where polluting discharges contain normally only a few hundredths of one percent of solids, metals, or organic matter; effluents only one-tenth this concentration; and streams only one-tenth the concentration of most effluents. Thus industrial wastes must be considered a "micro" category of manufacturing processes.

Little goes a long way

It actually surprises a manufacturer who thinks he operates an efficient process to learn how deplorable his losses are when they are discharged into streams. After becoming familiar with the ordinary range of concentrations specified, it is enough to floor him to learn about toxic concentrations of chromium, copper, or cyanide, and finally to receive the coup de grace by recognizing phenol limits, down around 5 parts per billion, or 0.0000005 percent.

Most industrial wastes, fortunately, are amenable to treatment processes which will reduce the concentration of pollutants to the range where streams are able to accept the residues without harm. Inasmuch as adequate means are available to abate the effects of industrial wastes on streams, the problem becomes largely one of economics. Inter-plant salvage or change of process are sometimes possible. Frequently such methods of pollution abatement avoid the necessity of installing relatively expensive treatment plants.

Wastes defined

Definition of what constitutes industrial or trade wastes is difficult. Broadly, they are the discarded end products or byproducts of any commercially operated chemical or physical process. Usually they are liquid or water-borne. Liquid wastes may contain both dissolved and suspended materials; these may be organic, inorganic, or both.

An important characteristic of industrial wastes is their great variability both in quantity and composition. They will vary not only with the type of industry, but also with various processing methods used in the same industry. Even in individual plants the character and volume of wastes may vary widely over a short period of time. This is especially true for processes operated batchwise or intermittently.

Wastes classified

In spite of the great variety of wastes, we might classify them according to the following simplified system:

Organic: Packinghouse, tannery, canning, beet and cane sugar, dairy, fermentation, glue and gelatine, starch, vegetable oils, antibiotics.

Toxic: Cyanides, phenol, atomic energy.

Metallic: Pickling, copper, chromium, electroplating.

Chemical: Acids, alkalis, soap and detergents, dyes and intermediates, pulp, paper, textiles.

Mineral Oil: Refining, brines.

Inert: Silt, sand, lime, sawdust, ore tailings.

Wastes described

The characteristics of these groups differ. Organic wastes are very troublesome, sometimes aggravated by abnormal conditions listed under toxic wastes. Metallic wastes are widespread and difficult to remove but in general are not of first importance as stream polluters. Chemical wastes are among the worst, especially if they include pulp, paper, and phenol. A specific type of chemical waste, mine drainage, is troublesome in certain parts of the country. Oil skimming is still a largely untouched abatement possibility.

Various types of industrial wastes are described more specifically in the table on the following page.

There are general objectives in waste disposal, most important being stream disposal, with limited flow during certain seasons of the year. In such problems the dissolved oxygen depletion and the critical point of dissolved oxygen content are most important. Standards range from 3 to 5 ppm. of dissolved oxygen for maintenance of fish life, and higher if the stream is to be used for water supply or recreation. At the same time, B.O.D. (biochemical oxygen demand) should not exceed 2 to 5 ppm., and reaeration must be included in the assets available for stream purification.

Usually the problem can be limited to (*a*) clarification of waste, (*b*) artificial increase of minimum stream flow, or (*c*) use of holding lagoons for low-water periods. Thus complete treatment of the waste may not be necessary. Sometimes salvage efforts are sufficient to avoid all types of treatment.

Such problems warrant thorough study by competent experts, following a well-planned campaign of sampling and gaging plant wastes. Every large company nowadays should employ a sanitary engineer or a chemical engineer as a waste specialist.

Study the process

Salvage comes first. Practically any industry can reduce its wastes by intelligent survey of processes, change of processes, recovery of usable byproducts, or evaporation of highly concentrated wastes. When such a program has been carried to economic limits, it is time to consider treatment, but not before all salvage efforts have been exhausted.

Industrial chemists are becoming much more familiar with chemical criteria used by sanitary chemists. Some of them have attempted to improve on the B.O.D. test by substituting a variation of the old "oxygen consumed" test,

SOURCES AND CHARACTERISTICS OF VARIOUS INDUSTRIAL WASTES

Source or Type of Waste	B.O.D. in Ppm.	Suspended Solids in Ppm.	Other Pollutants	Remarks
Packinghouse	800–2,000	1,000–4,000	Grease: 100–500 ppm.	Troublesome because of large volume, excessive nitrogen, and grease.
Tannery	500–2,000	2,000–4,000	No free grease, moderate nitrogen	Excessive suspended solids, lime, sulphides; difficult to treat.
Canning	600–3,000	500–5,000	———	Rapid anaerobic putrefaction, development of acidity, objectionable liquid.
Dairy	400–4,000	300–2,000	———	Lactic acid, putrefaction, not amenable to chemical treatment.
Distillery	10,000–20,000	5,000–40,000	Nitrogen: 500 ppm.	Highly concentrated, usually recovered by evaporation or treated by anaerobic digestion.
Brewery	400–1,000	500–2,000	Nitrogen: 50 ppm.	Yeast residues, grain filtration losses, wash water, etc.; treatment by biological filters.
Vegetable oils	2,000–4,000	500–1,000	Acidity: pH 2.0 or less	Highly acid; organic solids not amenable to chemical treatment.
Antibiotics	2,000–10,000	1,000–3,000	Toxic solvents	Toxic solvents must be removed, solids settled, liquid aerated, then biological treatment.
Cyanides	———	———	CN: 5,000–20,000 ppm. in plating solutions 10–50 ppm. in wash water Metals: various concentrations	Chlorine treatment; influent at sewage works less than 1.0 ppm.CN; fishing streams, less than 0.1 ppm. CN.
Coke byproducts, normal	2,000–4,000	———	Phenol: 1,000–3,000 ppm. N as NH_3: 1,000 + ppm.	Dephenolize, treat effluent in activated sludge process.
Coke byproducts, deammonified and dephenolized	200–400	———	Phenol: 200 ppm. N as NH_3: 50 ppm.	
Atomic energy	Not vitiated by emanations	Minute	———	Store until emanations of short half-life elements are dissipated; eternal storage of high residual energies.
Steel or iron pickling				
Pickling soln.	———	———	———	Adopt Chemical Construction Co. or Martin continuous pickling, or precipitate with lime or limestone, or dilute in stream if flow is adequate.
Wash water	———	———	———	Dilute and discharge.
Copper				
Pickling soln.	———	———	———	Must not be discharged to sewers; recover Cu chemically or electrolytically; cement out Cu on iron filings.
Wash water	———	———	———	Pass through iron filings; keep copper below 1.0 ppm. at sewage treatment plant or in streams.
Chromium				
Plating soln.	———	———	———	Recover Cr.
Wash water	———	———	———	Keep Cr below 15 ppm. at sewage treatment plant or in streams.
Electroplating				
Plating soln.	———	———	———	Make alkaline with NaOH, add chlorine water or hypochlorite, discharge to waste.
Wash water	———	———	———	Chlorinate, if necessary.
Mineral acids	———	———	Low pH	Use stream alkalinity to neutralize; add lime if stream is acid; keep pH above 6.0.
Soaps and detergents	———	———	———	Clarify with chemicals; sewage difficulties absent unless some detergents are present in excess of 100 ppm.*
Dyes and intermediates	———	———	———	Phthalic anhydride must be condensed and removed from sewers; sulphur black and sulphur colors should be decomposed; aniline losses prevented.**
Sulphite pulp	5,000–20,000	2,000–40,000	Nitrogen: low SO_2: 3,000 ppm.	New plants—use magnesium or ammonia process; old plants—use lime preferential precipitation, fermentation of organic residue.
Sulphate pulp	1,000–2,000	2,000–5,000	Sulphur: appreciable	Wastes processed and usable products recovered.
Paper	200–1,000	300–2,000	———	Savealls desirable; screens, tanks, filters, flotation units; anaerobic digestion for strawboard wastes.
Textiles	500–1,000	500–4,000	———	Removal of sulphides desirable.
Oil field brines	———	———	NaCl: 10,000–20,000 ppm.	Discharge into wells.
Refinery losses	———	———	Oil and phenol residues	Oil removed in API clarifier; phenol by biological treatment; sulphur removed.
Viscose rayon	———	———	Largely acid losses	Lime treatment; organic matter relatively minor.
Synthetic phenol	———	———	———	Solvents and recovery.
Synthetic rubber	———	———	———	Screen out or settle curds.
Furfural	———	———	———	Dilute waste acetic acid.
DDT	———	———	———	Neutralize waste acid.
TNT	———	———	———	Stream dilution.

*Detergents cause foaming but do not ruin effluent, unless present in excessive concentration. "Synthetic detergents do not appear to be having any significant effect in this country (England). There have been a few reports of foaming, but in the main the complaint appears to have been against unsightliness or inconvenience, rather than in regard to any interference with the purification processes." (Quoted from an English journal, Feb. 1951.)

**Colors are difficult to remove but in general are not detrimental. Some difficulty has occurred in sale of activated sludge containing red-colored residue of fuchsin discharge.

now referred to as "C.O.D." This test is based on use of sodium bichromate, rather than potassium permanganate, and reflux digestion for an hour or two, in order to approach 100 percent wet combustion. The test is not so simple, however, and the results appear to have little relation to the biochemical requirements for dissolved oxygen in the streams.

Bacteria and O_2

There is also a school of thought that biological surveys of microorganisms are a better measure of stream conditions than engineering data and the oxygen balance based on B.O.D. and D.O. Of course, a biological survey has its place in stream studies, but it is a relatively minor complementary test, or one of a semi-qualitative nature, compared with the more precise quantitative basis of the oxygen relations.

We must learn more about the vagaries of B.O.D. of industrial wastes and the fundamental importance of the concept of oxygen balance. It is true the B.O.D. test is far from satisfactory as a precise determination, but it is a biological test related to stream disposal conditions and it should be improved or modified so that it meets this requirement.

Pollution of lakes

Stream disposal is not the only problem facing the process industries in disposing of liquid wastes. Wastes are frequently discharged into lakes and, while there may be no health hazard due to pathogenic bacteria, the organic matter may cause a rapid variation in the chlorine demand of the water. Where the water is used for drinking, these fluctuations may result in failure to apply enough chlorine, thus constituting a definite health hazard. This hazard is recognized in Lake Michigan, in the Niagara River below Buffalo, and in the St. Clair River below Detroit. In such examples of lake disposal,

B. O. D. is of secondary importance; the principal problem is one of chlorine demand and the reduction of coliform organisms.

Accurate sampling and flow measurement are essential to any pollution study. The various methods used to obtain accurate volumetric flow measurements will not be described here at length; the reader may refer to standard works on hydraulics for additional details. It is our general practice to use rectangular, trapezoidal, or V-notch weirs for measurement of flow, and to take samples manually every 15 min., compositing into 12 or 24-hr. samples. If concentration or character of wastes change frequently and for reasons of plant operating schedules, it may be necessary to analyze individual samples, rather than composites.

Process industries' problems

The process industries have special problems of acid wastes and corrosion of metals by water containing such wastes; problems of toxic wastes and removal of copper, chromium, or cyanides to permit normal stream or lake conditions; and above all, the problem of phenol pollution, and tastes and odors. The latter is worldwide, with peculiarly aggravated conditions in the lower Rhine similar to conditions along the Ohio River.

We may therefore conclude that industrial waste investigations and disposal have many phases, so that generalization of the problem is inadvisable. Each condition may require some special type of alleviation, unnecessary under other conditions.

Patient study is required

The same methods of study and solution appear applicable to industrial wastes as to sewage disposal, if we are patient enough to evaluate all angles to the problem. Some of these are the improvement of the B.O.D. test, elimination of toxic chemicals, removal of sludge-forming solids, study of stream biology, correction of oxygen balance, removal of taste-producing chemicals, and elimination of widely fluctuating chlorine demands. Industrialists need not be discouraged by these many requirements, but should continue their studies so that waste disposal will become as well understood as sewage disposal.

Sampling and Metering Are Basic

Adequate and economical pollution control requires accurate fundamental data on flow and composition of wastes.

EDITORIAL STAFF

Ignorance is not bliss

Determination of the extent of the pollution problem in your own plant requires an accurate knowledge of the composition and flow of process discharges. Armed with adequate data, you will be in a favorable position either to defend your continued operations or to find the most economical methods for pollution control. Such data can be obtained by gaging, sampling, and analyzing the various waste streams. Methods of analysis constitute a broad field, of more interest to the laboratory chemist than to the chemical engineer; no attempt will be made here to discuss this subject.

If flow and composition are known to be reasonably constant throughout the test period, spot samples taken at regular intervals can be composited to yield a fairly representative sample. If the flow changes in volume from hour to hour but the concentration of pollutants is relatively constant, proportionate samples can be taken. If the wastes change in character, inspection of each individual sample, rather than a composite, should be made.

Problems in phase separation

Sampling is quite a problem when the liquid waste stream contains substances having specific gravities decidedly different than water. For example, light oils will concentrate near the surface, and inorganic precipitates will tend to collect on the bottom, making it difficult, if not impossible, to collect a sample containing these substances in the same proportions in which they are present in the stream.

Sampling methods may be either manual or mechanical. The reliability of hand sampling depends almost entirely upon the judgment and care exercised by the sampler. Mechanical sampling, on the contrary, practically eliminates the human factor once the equipment has been properly installed. The most common shortcoming of automatic samplers is their failure to collect the sample across the entire cross-section of flow.

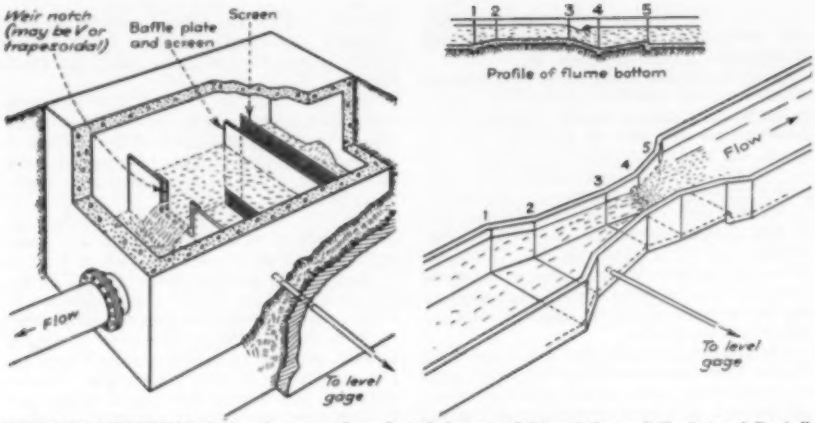
Intermittent sampling

Automatic sampling may be either intermittent or continuous. In either case a flowmeter is used to record the flow and actuate the sampling mechanism. For intermittent sampling, the meter is equipped with a device which generates impulses in proportion to the flow. These impulses are fed into a counter, which adds them up to some desired value; the counter then closes a contact on a timing relay. If the flow is in a line which is elevated or under pressure, the sample may be withdrawn through a solenoid-operated valve. For intermittent sampling from an open channel, a pump can be started and stopped in accordance with impulses from the relay.

Continuous sampling

Continuous sampling employs a flowmeter which transmits a pneumatic signal linear with flow rate. This signal can position a diaphragm control valve or, as shown in the illustration, can adjust the output of a plunger pump. Another method uses an electronic system to vary the speed of a rotary pump.

Flows can be measured by orifices, nozzles, or weirs. Use of orifices is limited to cases where



PRIMARY METERING devices for open channels include weirs (left) and the specially designed Parshall flume (right), which is useful where the liquid contains suspended solids.

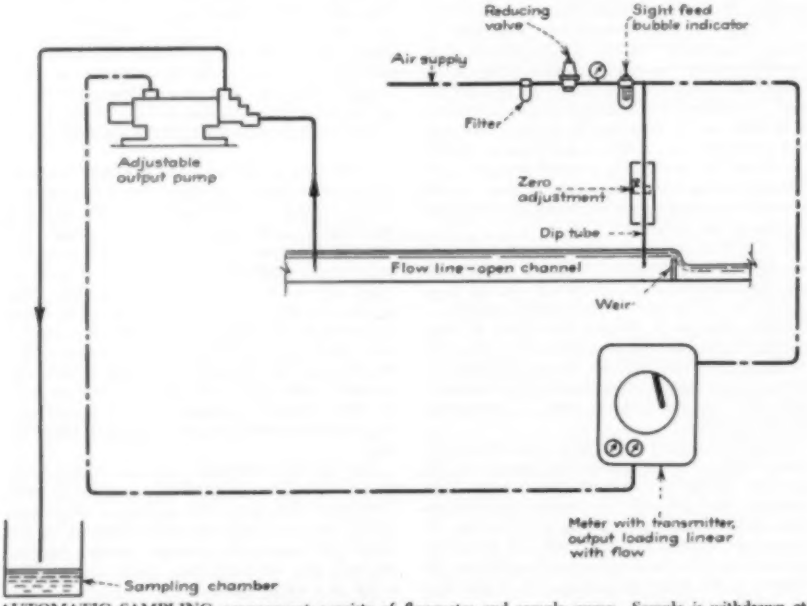
the liquid is clear and the line is under pressure and running full. Rectangular weir notches are frequently used for all types of open channel metering services. If the liquid being measured is substantially clear and an exceptionally wide flow range is desired, a V-notch weir can be employed to advantage. Trapezoidal and specially curved weirs find limited use; in general they do not have any particular advantage over the much simpler rectangular and notch weirs.

Parshall flume

An extremely useful device for flow measurement in open channels is the Parshall flume. The chief advantages of the flume are its ability to handle liquids containing suspended solids (there is no point at which solids can collect or settle) and its low head loss. While the accuracy obtainable with a flume installation is not quite as good as that with a weir, it is considered satisfactory for most waste disposal problems.

For more information

The reader may wish to refer to standard works on hydraulics for further details on installation and calibration of open channel metering devices. For a discussion of problems involved in sampling and gaging of liquid wastes, see the article by C. F. Hauck in the ASTM Bulletin for Dec. 1949, p. 38.



AUTOMATIC SAMPLING arrangement consists of flowmeter and sample pump. Sample is withdrawn at a rate proportional to the flow of waste in the channel.

DETRITOR removes grit from liquid wastes by providing adequate settling area at low flow velocity.

First Remove Solids from Your Wastes

Good practice in treatment of liquid wastes calls for separation of suspended solids. Here is a round-up of modern methods.

EDMUND B. BESSELIEVRE and ANTHONY ANABLE, The Dorr Co., Stamford, Conn.

Purity vs. $

The prime objective in devising a treatment plant for any form of industrial waste is to fulfill the requirements of the compelling authority but at the same time provide means that will not bankrupt the industrial plant owner. All industrial wastes can be treated to produce an effluent of any degree of fineness up to the ultimate end of drinking water. However, in very few cases is this necessary and to insist upon it imposes an inordinate burden upon the plant owner.

This discussion basically covers industrial wastes in general and is not devoted primarily to chemical plant wastes. Although chemical wastes may contain small amounts of solids in suspensions, they are usually either highly alkaline or acid or contain phenols, cyanides, and other chemical compounds in solution. These contaminants are pollutional in character but do not respond to the methods of treatment covered in this paper.

Many liquid industrial wastes contain solids in one form or another. These solids in many cases are the most difficult constituent of the waste to treat adequately and economically, while in other cases the liquid portion is the main source of trouble and expense. This paper will discuss only the means available for the separation of the solids from the liquid portion of the wastes and the ultimate treatment of these solids to prevent subsequent nuisance.

Practically all solids in industrial wastes, except those in solution, will respond to one or more of the methods normally employed in the field of sanitary engineering for the removal of solids carried in sewage and water. These methods are: (1) interference; (2) gravitation; (3) assisted gravitation, or precipitation; (4) flocculation; (5) flotation.

First step

Many wastes contain large solids, such as fibers, materials like wool, cotton, sisal, rubber and refuse from slaughtering and packing houses, tanneries, and glue factories. These large solids are best removed by interference, that is, by means of screens. Interference is usually the first step in any treatment plant, as it removes those solids which tend to clog pumps and pipelines.

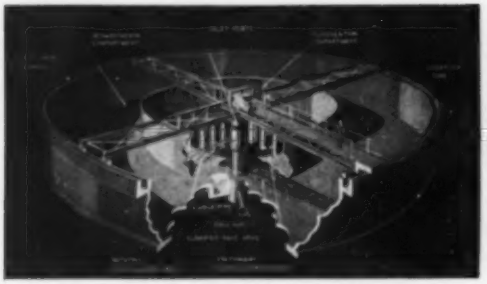
These units may be either of the fixed bar type with movable rakes to remove the accumulated material, or fine screens, which are either revolving drums covered with perforated plate or sloping disks. There are numerous units of this type marketed by several firms. These units will remove a great proportion of the solids which are larger than the openings or perforations in the screen and will collect the solids and transport them to conveniently placed receptacles on an upper level. From here the solids may readily be removed to dumps or incinerators for final disposal. This method is especially recommended for those solids which will not decompose and which, although disintegrated, would still form troublesome films and scums on sedimentation and digestion units.

Little ones from big ones

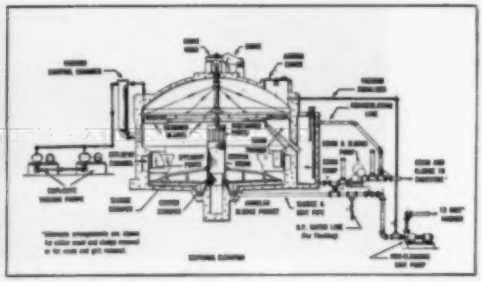
A modern form of interference unit is that known as the Comminutor. Although there are several forms, they all in principle consist of a slotted drum set in the path of flow of wastes, provided with a revolving or reciprocating cutter which slices the solids trapped on the surface of the drum into small bits. The comminuted solids can then pass through the apertures in the drum to subsequent treatment units. When the shredded solids are of a nature that they will decompose or settle or float, this method is justified.

Removing inert solids

Following the removal of the coarse solids, there is, in many wastes, a class of solids which is relatively inert, such as dirt, sand, etc., removed from hides, skins, wool, cotton, and other raw materials. This inert material also is a detriment in the sedimentation and digestion units, as in its normal form it accumulates in tanks and pipelines and reduces the effective capacity of these units. This material, usually with a specific gravity greater than 1.0, will respond to normal gravitational methods.



CLARIFLOCCULATOR provides tortuous liquid path, promoting agglomeration of suspended solid particles.



VACUATOR skims off light or non-settleable solids which have been previously aerated.

Low velocity does it

These solids are carried along in the flow of wastes when the transporting velocity is sufficient to move them, which is usually above 1 fps. It has been demonstrated that when the velocity of flow is reduced to 1 fps., much of this material will settle to the bottom of a properly designed chamber. A commonly used unit for this purpose is known as the Detritor. It employs a small sedimentation tank, based on handling a given volume of flow at a maximum velocity of 1 fps. It is equipped with a sludge collection unit which transports the collected deposit to an integral washing element in which the putrescible organic material in the deposit is floated off and returned to the main flow for further treatment. The washed solids, relatively low in moisture content, are eventually discharged from the end of the cleaning deck into a conveniently placed can or cart. Detritors are normally rated to remove from a waste 95 percent of any material over 65 mesh.

Variations of this type of unit include those with long, narrow channels equipped with sludge collecting mechanisms and provided with washing elements. They all achieve approximately the same results.

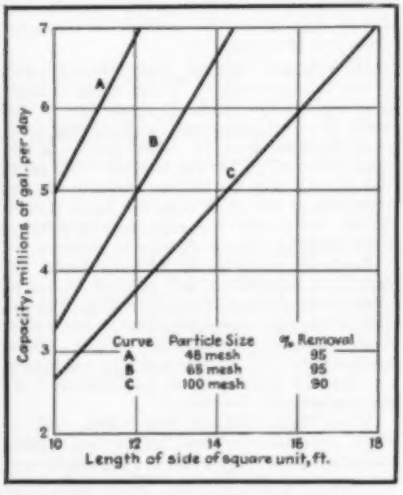
After the removal of inert solids, there still remain, in many wastes, the putrescible or decomposable organic solids which, in most cases, are the main cause of the pollution difficulty. These solids are usually of such a nature that they will respond to one of the methods of removal such as gravitation, assisted gravitation, precipitation, flocculation, or flotation.

Removing organic solids

If these solids have a specific gravity greater than 1.0 and do not possess a high surface area in comparison to their weight, they will normally settle in a convenient tank when the velocity of flow is reduced to a fraction of a foot per second. Normal sedimentation, based on 2-3 hr. detention of the liquid to be desolidized, will remove from 75 to 80 percent of these settleable solids. They will be collected in the bottom of the basin in the form of a sludge or mud. Suspended solids whose specific gravity is closer to 1.0 settle more slowly, and the amount removed may be on the order of 50 to 55 percent with the same periods of detention.

Many wastes, on the other hand, contain large volumes of solids which will not settle readily at short detention periods, or which

COMMINUTOR chops up coarse suspended solids.



DETRITOR capacity varies with particle size.

have such a large surface area that surface tension tends to hold them in suspension for periods uneconomically long for tank structures. Furthermore, many fine solids, although heavy enough to settle rapidly under quiescent conditions, will not settle if there are any currents caused by convection or short circuits. If these fine solids, however, are agglomerated into larger, more compact masses, they will then settle with normal speed. This brings in the phase of assisted gravitation.

Big ones from little ones

To cause fine solids to agglomerate into heavier masses, two means are commonly employed. One is known as mechanical flocculation. A series of paddles causes the fine solids to follow multiple paths through all zones of the liquid, during which time they impinge on one another and by the forces of adhesion and adsorption form larger, denser, quick-settling particles. In addition, the larger particles themselves act as filters as they pass through the liquid, picking up additional fine particles.

The second phase is air flocculation. A small volume of compressed air is passed through the liquid, causing the light solids to circulate through the various zones of the tank and carrying out the same general effects as with mechanical flocculation. Either of these units has been shown to increase the removal of suspended solids by 15 to 20 percent over unassisted sedimentation. In the most modern form, this operation is carried out in a single tank equipped with a separate central flocculation compartment suspended in the sedimentation compartment. Speeded sedimentation permits the use of smaller units, resulting in lower initial costs, or greater removals may be obtained in a unit than would be achieved by plain sedimentation.

Variations in design

In modern practice the sedimentation units employed, equipped with sludge collection mechanisms, are commonly called clarifiers and are similar in many respects to the well known thickeners used widely in the chemical industry. These may be of various forms—circular, rectangular (long and narrow), or square, and may be equipped with revolving mechanisms driven from the surface or with chain drag mechanisms. Still another form, used for rectangular tanks, is a traveling bridge which supports a scraping blade following the bottom of the tank. The more modern units equipped with flocculation devices are normally circular or square and are provided with revolving paddles, air nozzles, or porous plate diffusers in the flocculation compartment.

Those solids which have a specific gravity of less than 1.0 or are colloidal in nature, or immiscible liquids such as oils, fats, greases, soaps, etc., which tend to float rather than settle, may be collected as a scum on the surface of sedimentation units if sufficient detention time is provided and there is freedom from convection currents and surface disturbances. Frequently, however, the time element required to achieve this unassisted flotation entails such large units that other means must be considered.

Vacuum to the rescue

The operation of flotation may be accelerated by the use of vacuum to pull the solids to the surface at a much more rapid rate. A unit known as the Vacuator achieves good results in this regard, giving very high percentage removals of suspended matter with very high rates of overflow. In a normal unassisted sedimentation unit a rate of overflow of between 800 and 1,000 gal. per sq. ft. per day is considered satisfactory. This may be increased to 1,200 to 1,500 when flocculation is added, but with the Vacuator wastes may be handled at rates of from 5,000 to 10,000 gal. per sq. ft. per day and still obtain removals comparable to those obtained in normal sedimentation units.

The Vacuator operates on the principle of first aerating the waste to be treated to add buoyancy to the light suspensoids, and then passing the aerated waste into a tightly closed chamber which is under a vacuum of 9 in. Hg. The combination of buoyancy and vacuum brings the particles to the surface of the tank, where they collect in the form of a thick scum for removal by duplex skimmers. This unit is especially valuable for those wastes which contain a large proportion of light solids and fibers that will not settle, either with or without assistance. Due to the high rate at which the unit may be operated, the units for even large volumes of flow are relatively small, reducing construction and operating costs. Performance data are summarized in the accompanying table.

Filtration, pro & con

Additional methods of removal of solids are mechanical filtration, gravity filtration, and lagooning or ponding. Filters of coarse or fine sand, anthracite coal, finely ground coke, magnetite sand, gravel, etc., have been used to remove solids, but filtration is usually not economical and cannot compare in cost with plain or assisted sedimentation. The beds of filter material eventually clog and require periodic cleanings or backwashing. These cleanings entail the provision of considerable apparatus in the way of valves, piping, etc., and spare filters must be provided to permit operation of the system while others are being cleaned. Another item of expense is replacement of filter material.

Rotating vacuum filters can remove fine solids by coating the drum with an inert material which forms a mat on the surface to trap the solids. This method would ordinarily be uneconomical because of the high cost of equipment, periodic replacement of filter media, and other maintenance and operation costs.

The economy of using vacuum filtration, how-

Removal of Grit and Suspended Solids by Vacuum*

Test No.	Sewage Flow MM Gal./Day	Sewage Flow Gal./Sq. Ft./Day	Grit Cu. Ft./MM Gal.	Grit % Dry Solids	Suspended Solids Raw Ppm.	Suspended Solids Effluent Ppm.	Suspended Solids % Removed	Total Solids Raw Ppm.	Total Solids Effluent Ppm.	Total Solids % Removed	Date of Test 1945
15	0.216	7,640	4.09	51.7	250	150	40.0	662	570	13.7	5/2–5/9
16	0.288	10,180	5.12	55.5	244	155	36.5	651	559	14.0	5/10–5/16
18	0.432	15,280	3.46	44.6	279	216	22.6	715	653	8.8	5/25–5/31
19	0.360	12,700	3.72	49.8	278	210	24.5	674	609	9.6	6/1–6/7
20	0.144	5,090	5.98	50.7	270	168	40.0	715	604	15.5	6/8–6/14

*From Reference 11.

ever, must always be considered from the standpoint of available space and location of plant. While a mechanical filter installation may cost more to install and operate than sedimentation equipment, space availability in the plant or the necessity for having the unit inside a building may dictate the use of the vacuum filter despite its apparent lack of economy. When waste treatment is considered, though, it is usually an out-of-doors project where space limitations are not critical.

Recovery of solids

Evaporation of wastes to dryness has been used where the recovered solids may be disposed of by incineration or as fuel, or even in some cases as stock food, such as the spent grain in the wastes from breweries and distilleries. In general however, this method is not economically practicable. Usually the proportion of solids to liquids in any waste is very low, averaging less than 1 percent. Therefore, the fuel required to evaporate the 99 percent of water is an item of expense involving exorbitant costs. Solids removable by sedimentation or one of the other methods described earlier, in the form of a thick sludge with a solids content of from 4 to 8 percent, may be handled quickly and economically by vacuum filters, heat drying, or even sun drying to a point where they may be readily disposed of.

The methods of solids separation discussed are all applicable to wastes of various kinds, but the selection of a particular one for a given waste and plant is a problem for the engineer.

Disposal of solids

The solids collected by these different methods must be disposed of economically and without nuisance. Material collected on screens, either coarse or fine, may be combined in many cases with the garbage of the local community, or a small private incinerator may be installed. In other cases where ample area of waste land or wet ground exist, these screenings may be buried or combined with municipal refuse for land-fill schemes. Inert material, collected in grit chambers or Detritors and washed free of organic matter, is frequently used as fill in low ground or as soil for walks and roads. It has even been used as an aggregate in low grade concrete for walks and paths.

Anaerobic digestion

Disposal of sludge from sedimentation or flotation units is a greater problem. This sludge is usually in a range of from 4 to 10 percent solids, and when it contains much organic matter subject to decomposition and the production of odors, it must be handled in a different manner. When the sludge contains a large proportion of volatile organic matter, around 50 to 60 percent, the best method of reducing this material to an innocuous substance is by means of anaerobic digestion. In this system the wet sludge is pumped into concrete digestion tanks, usually completely closed, and allowed to undergo the normal course of decomposition of organic matter. The tendency of organic matter is to go through a series of stages during decomposition. The first is acid, which is productive of the nauseous odor of hydrogen sulphide, before it reaches the phase of alkaline digestion. The modern method in the digestion units, therefore, is to put the mass of digesting material in the tanks in an alkaline condition so that the small daily added increment of sludge never creates acid conditions. The result of this reaction correction is the production of an appreciable volume of methane, which not only avoids a nuisance but has a definite fuel value.

Warm climate preferred

The action in these digesters is entirely bacterial. This action becomes dull at temperatures lower than 50 deg. F. and is most active at temperatures between 85 and 90 deg. F. The modern digestion system, in the colder climatic regions, includes means to heat the contents of the tanks to the optimum point. Although frequently these tanks are large, sometimes 75 to 100 ft. in diameter, this heating is not an expensive operation, as the byproduct gas may be used as a fuel. Heat may be transferred by means of horizontal coils around the inside tank walls or vertical coil suspended heat exchangers, through which the hot water is circulated, or by an external heat exchanger through which the sludge or supernatant liquor from the digester is passed to absorb heat from the hot water and then returned to the digester.

Products of digestion

After a period of between 20 and 30 days in the digestion system the organic material is resolved into its three basic end products—gas, liquor, and inert burned out core. The burned out core, when in prime condition, is a brownish black mass which has a relatively pleasant moldy earth odor. Discharged to open sand drying beds, it dries well and may be removed by spades and used as a soil conditioner or mild fertilizer. In those cases where ground area is valuable or limited and the volume of sludge is large it may pay to investigate dewatering by means of a vacuum filter. In vacuum filtration the wet sludge from the digestion tanks is conditioned with a chemical agent to produce homogeneity in the mass. It is then fed to the filter drum, which is covered with a suitable medium, usually wool or cotton cloth. The filter cake may be handled by belt conveyor to a drying system for use as fertilizer or to an incinerator for complete disposal.

Recovery of gas

The gas formed in the digestion step, is, as stated, a valuable fuel, especially in large plants. This gas normally has a heating value of around 650 Btu. per cu. ft. With the modern dual fuel type of gas engines, especially developed by several makers for use with sewage sludge gas, 1 kwh. of electrical energy may be produced for a total input of around 9,000 Btu., of which about 95 percent is obtained from the gas and the remaining 5 percent from the diesel oil which is used as a flame propagant in the engine. As normal alkaline digestion usually produces about 11 cu. ft. of gas for each pound of organic matter put into the digesters, a rapid computation can be made of the energy that will be available from an organic waste when the amount of organic matter is known. In large plants it does not pay to neglect consideration of this potential source of cheap power.

In this paper no attempt has been made to discuss the methods which may be employed to treat the liquid portion of industrial wastes to prevent stream pollution, as this is the function of the next article. With the most efficient pretreatment, or the removal of the greater bulk of the solids, the secondary treatment will be

Study the whole problem

simplified and reduced in cost. The two elements of pre-treatment and secondary treatment are necessarily closely linked. The conscientious and skilled investigator will consider the problem as a whole, endeavoring to derive the method that will satisfy the requirements of the authorities and yet still be economical.

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If Your Wastes Need Not Be Separated—

The receiving waters may provide adequate dilution for untreated clear liquid wastes. If not, chemical or biological treatment before disposal is indicated.

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The goal of industrial management and engineering in regard to pollution control is to achieve the fullest possible conformity with law and public opinion at the least possible cost. Previous articles in this report have discussed the "what" and "why" of the water pollution problem and the engineering "how" of separation of suspended solids. Here we shall deal specifically with problems of disposal and treatment of liquid wastes from which suspended solids have been already removed. Wherever suspended matter is present in sufficient concentration to require treatment, it can usually be economically removed from the waste by mechanical methods.

Broad principles apply

It is necessary that we limit ourselves to a general approach, for no two individual industrial waste disposal problems are ever exactly alike. Despite this fact, however, certain common engineering principles are involved in the solution of pollution problems. It is with these broad principles that we are concerned. With his unexcelled training for tackling varied aspects of chemical processing, the chemical engineer, assisted in some cases by the sanitary engineer, should have little difficulty in forming from the basic principles a method of attack for each specific waste disposal problem.

Character of stream

Whether or not the effluent must be treated depends not only upon the nature of the effluent but also upon the characteristics of the stream into which it is discharged. From the standpoint of economy, naturally, treatment of wastes should be undertaken only if found to be necessary. The first step, then, is to determine the nature of your wastes and the ability of the stream to dilute them, purify them, and carry them away without creating a nuisance.

Data on stream flow are collected at gaging stations by the U. S. Geological Survey and the U. S. Corps of Engineers. The information is published annually by the Department of the Interior for all sections of the country under the title "Surface Water Supply of the United States." These reports cover all of the major river systems and most of the tributaries and include such data as drainage areas, periods of record, daily flows for the year of publication, extreme maximums and minimums, and long term average flows. These water-supply papers can be purchased from the Government Printing Office and are also in most public libraries.

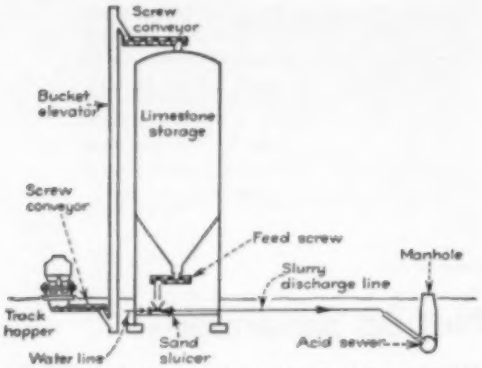
What some streams can do

The capacity of some streams to absorb wastes is remarkable. In the case of one of the wartime powder plants on the Ohio River, it was possible to discharge many tons per day of mixed acid (300 to 400 tons under optimum conditions) into the river without neutralization. The acid effluent entered the river from a drainage ditch which ordinarily was a small spring-fed creek. Mixing conditions in the river were so highly favorable that nearly complete dispersion was accomplished 2,000 ft. below the point of discharge. At another ordnance plant on the Coosa River in Alabama, the highly-colored red water was dissipated so thoroughly under ordinary conditions that, at a point one-half mile downstream, no color difference could be detected in samples taken in cross-section.

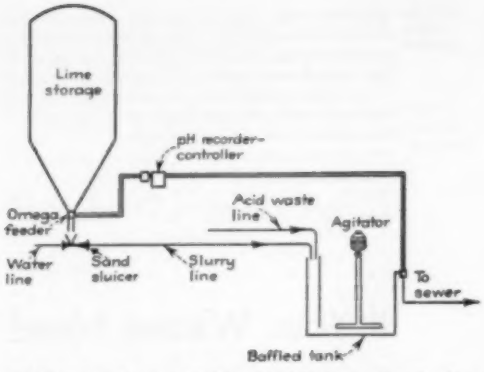
Suppose that your study of stream characteristics indicates that the minimum reported flow will be sufficient to dilute your wastes to a level acceptable to the regulating authorities. Will it be satisfactory merely to discharge the effluent through a ditch or pipe emptying at the bank of the stream? The answer is sometimes yes, many times no. It all depends upon the flow pattern of the stream.

Mr. Waste meet Mr. Stream

If the stream is fairly swift and there are no bank irregularities to create stagnant pockets, mixing of the plant effluent with the stream will probably be satisfactory when using the very simplest means of dumping the effluent into the stream. If the stream is lazy, however, and stratified flow or stagnant areas are known, you might have to run a pipe along the bottom out into the middle in order



LIMESTONE for acid neutralization must be fed in excess; pH control is impossible.



LIME feed can be controlled by pH of discharge. Reaction time is more favorable than when using limestone.

to obtain adequate dispersion. Multiple outlets are sometimes desirable. The pipe may be perforated at intervals or may terminate with a tee or cross fitting. The greatest engineering problem involved here is the anchoring of a pipe extending into the stream, especially where the river is wide and subject to extreme variations in flow. The writer knows of a case where the life of a 1,000 ft. long disposal line was less than a year. Calco's well-known solution to the problem is to carry the disposal pipe inside a dam across the Raritan. Another idea is to run the pipe into deep water, supported by a convenient jetty or pier.

Mountain to Mohammed

In some European plants, especially in Germany, wastes are pre-diluted by pumping river water into the plant, mixing it with the wastes, and pumping out again into the river. This practice has been used particularly for cyanide wastes, where good dilution is absolutely essential. It is also applicable to disposal of salt brines and chlorides. The economics of such a practice will depend on the particular circumstances involved. If river water in quantity is already being used for cooling purposes, it might economically be used for waste dilution before returning to the stream. In any event, before extending a pipe into the stream this "mountain to Mohammed" idea should be considered.

Disposal in tidal streams

The toughest disposal problems are those concerned with tidal streams. Even though the net flow is towards the sea, the instantaneous flow varies with the tidal cycle, and may even reverse itself. Rate of stream flow means very little and, in fact, the government publications referred to above do not cover tidal waters. Practically no information is available upon which to base waste disposal plans; there is a real need for basic data along this line.

One approach to waste disposal on tidal waters is the use of retention basins which impound the effluent for half the duration of the tidal cycle. Automatic sluice gates can be used to retain the effluent while the tide is coming in and discharge it when the tide is receding. This procedure, of course, means that the concentration of contaminants in the stream at the point of discharge will be greater than would be the case with a continuous discharge.

Disposal in ocean

Discharge of wastes along the sea coast involves problems unlike those encountered with discharge into streams. Since there is no particular direction of flow, except for the tides, you cannot dump plant wastes right at the shore and expect them to be quickly diluted and carried away. You might expect a 1:1 dilution at the point where the wastes are introduced, but there is no natural force like the flow of a river working in your favor.

Aside from actual waste treatment, there are two safe ways of avoiding difficulty. One is to load the waste into a barge and dump it far enough out at sea to avoid any argument. This method is entirely practical if the waste is fairly concentrated. The other solution is to pump sufficient sea water into the plant to achieve adequate dilution before discharge.

Disposal in lakes

Discharge of polluting wastes into fresh water lakes is a still more ticklish problem, especially if you or your neighbors are drawing fresh water from that part of the lake. You must either make sure that dilution is adequate, or perhaps you will find it advisable to treat the waste to render it non-polluting.

Disposal in ground

Underground disposal of liquid wastes can be considered feasible in special cases. This practice is well established with the petroleum industry. Aqueous brines separated from crude oil are customarily pumped back into non-producing oil wells. The procedure is entirely logical—the brines came out of these wells in the first place.

This procedure should be approached with considerable caution, however. It is necessary to know the geology of the area thoroughly so that you will be sure that you are not polluting the ground water supply. In some states, in addition, you must get specific permission from the authorities. Publicity has recently been given to a Du Pont underground waste disposal installation at Victoria, Tex. (*Chem. Eng.*, Sept. 1950, p. 137). This practice was approved only after a careful investigation in cooperation with state officials had showed that there would be no harm done.

Waste disposal underground is not quite as

simple as might first appear. Although color, odor, and taste are of no concern, the waste must be free of suspended solids, particularly those of a fibrous nature, which might plug the well. Chemically, the effluent must not react unfavorably with the underground rock stratum. It is also desirable that the liquid not be corrosive toward the equipment used. Obviously, many wastes will require some sort of treatment in order to pass these qualifications. Underground disposal, therefore, is limited to wastes (such as chlorides) which ordinarily could not be disposed of in surface waters.

What it may cost

If an abandoned well is not convenient or suitable, a new one may be drilled for the purpose. On the Gulf Coast the cost for a 4,000-ft. well, completely equipped, is said to be about $40,000. Such a well will handle about 4,000 bbl. per day of liquid waste. The cost of a treatment plant for preparing the waste for underground disposal may be several times the cost of the well itself.

Suppose that you have carefully investigated the character of your effluent and the possibilities of its disposal by dilution and have found that the only way you can avoid pollution is to treat the waste by suitable means. Before starting to design a treatment plant, however, you should do two things: (1) Study the processes from which the wastes originate in order to check the pollution at its source, if at all possible. The chances are that you won't completely eliminate the problem, but you can probably reduce its magnitude. (2) Segregate the polluting process wastes from the nonpolluting cooling waters and wash waters. This will probably cheapen the required treatment.

Averaging will help

Inspection of wastes from a batch or multiproduct plant should cover a sufficiently long study period to get a good idea of average effluent conditions. Combining of wastes over a 24-hr. or longer period is desirable in order to even out surges of pollutants. Possibly some wastes will neutralize each other, such as by acid-base and oxidation-reduction reactions, and the blending of brightly-colored effluents often converts them to a less conspicuous neutral color.

The most common objectionable characteristic of chemical plant wastes is a low pH. In rather special cases, however, a plant may be discharging an alkaline waste. The pH range for the effluent should be between 4 and 9, or preferably between 5 and 8. If your effluent is outside this range, treatment is indicated.

Neutralize acid wastes

Acid wastes usually predominate in chemical plant effluents. Neutralization is universally effected by the addition of lime or limestone. Other alkalis are just too expensive to consider using in any quantity, unless they happen to be available in other waste streams.

The cheapest form of alkali is limestone, either dolomitic or high-calcium type. The choice between these two materials is largely a question of availability in the vicinity. Freight costs are high, compared with the cost of the stone itself, requiring that neutralization processes be designed around the use of locally available limestone wherever possible.

Ordinarily, dolomitic limestone may be purchased for about the same price per net ton as its high-calcium counterpart. Its neutralizing value, however, is approximately 15 percent greater. Its chief disadvantage, compared with high-calcium stone, is its extremely slow reactivity with sulphuric acid. This disadvantage is sufficient to make use of dolomite unattractive in many cases.

HCl and nitric are easy

Neutralization of hydrochloric and nitric acids is a relatively simple matter with any of the common alkalis because of the high solubilities of the resulting neutral salts. Reaction rates of these acids with high-calcium limestone are favorable. The cheapest treatment, which is, however, limited to clear effluents, is to pass them through beds of lump limestone. When the wastes are contaminated with solids, particularly fibrous matter, and where it is not convenient to settle beforehand, powdered limestone may be added in agitated tanks.

Sulphuric must be dilute

When handling sulphuric acid wastes the low solubility of calcium sulphate presents a complicating factor. Particles of stone will quickly become coated with a layer of calcium sulphate, hindering the chemical reaction, unless the effluent is sufficiently dilute. And, if disposal of the calcium sulphate as a water-borne waste is desired, the effluent must be dilute enough to carry it in solution. These considerations require that the concentration of sulphuric acid in the plant waste be kept below 0.3 percent, diluting with additional water if necessary.

Provision of adequate retention time is important when using limestone for sulphuric acid neutralization. If the capacity of the disposal system is not sufficient to provide a holdup of 30 min. or so, it may be necessary to supplement it with an agitated retention tank.

One way to do it

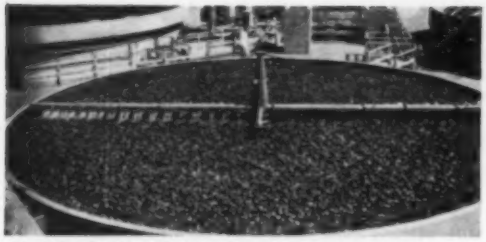
In a typical plant installation (see drawing), limestone ground to minus 20 mesh is fed by a screw conveyor, driven through a variable speed reducer, into a standard sand sluicer. This sluicer operates on ordinary plant water boosted to about 175 psi. by pumps. With this device it is possible to slurry the limestone in the water and transport the mixture a distance of 1,300 ft. to the point of application.

Sewer lines which transport the limestone-acid mixture are designed to maintain a minimum velocity of 3 fps. so that the unreacted limestone can be retained in suspension. In this way optimum conditions for reaction are maintained for about 30 min.

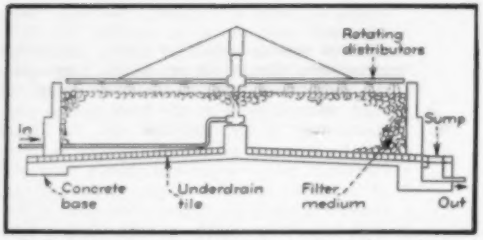
Automatic control of pH in systems employing ground limestone is difficult, if not impossible. During the reaction, carbon dioxide is liberated and remains in solution. This, coupled with the low solubility of calcium carbonate, prevents the rapid rise in pH which is normally associated with alkaline conditions. Aeration to help remove the CO_2 might be of some assistance, but usually you must be content to operate your neutralization system with a known excess of limestone.

Quicklime, pro & con

Use of quicklime or hydrate overcomes some of the difficulties associated with use of limestone. Of most importance is the fact that pH control becomes practical when using lime.



BIOFILTER in use at Kaiser's Fontana steel plant is shown in this Dorr installation. Flow rate is 600,000 gpd.



CONSTRUCTION of a biofilter is simple. Only moving part is the liquid distributor; nature does the rest.

Here, of course, CO_2 is absent and hydroxyl ion concentration can easily be measured. Another advantage is the much greater reactivity of lime, compared with limestone.

The chief disadvantage of quicklime or hydrate is cost. Even where limestone must be used to excess and requires long retention times, it is nearly always cheaper than lime.

Another way to do it

An installation for neutralizing acid with hydrated lime is also illustrated. The lime is removed from bulk storage by means of a positive type feeder. Hydrated lime is totally different from limestone in its handling and feeding characteristics. If it becomes aerated during handling it will flood through a non-positive feeder at the slightest provocation. If it is allowed to pack, it will arch and must be broken up by means of agitators or vibrators.

The mixing tank is made of concrete, lined with acid-resistant brick. It is of sufficient capacity to retain the mixture in a well-agitated condition for 2 min. The overflow is sent directly to the sewer. Electrodes of the pH recorder-controller are located at the overflow.

This system should be suitable for use with either high-calcium or dolomitic hydrated lime. The agitated tank would have to be four to five times as large if dolomitic lime were used in order to compensate for the slower reaction rate.

Alkaline wastes are generally treated with sulphuric acid, or with any other acid which might also be a waste product. Feeding and mixing can be done along conventional lines, introducing the acid directly into the effluent with suitable mixing and control equipment.

Another important class of process waste is organic matter. Even though organic matter in industrial wastes may be entirely of synthetic origin, it pollutes streams in the same manner as does domestic sewage, except for the absence of pathogenic bacteria. The ability of streams to purify themselves is marvelous, yet they can be just as easily polluted by industrial organic chemical wastes as by domestic wastes.

Biochemical oxygen demand

Concentration of organic matter in a waste stream is generally expressed in pounds of B.O.D. Biochemical oxygen demand is a measure of the amount of dissolved oxygen which may be absorbed from a receiving water in the oxidation of the organic pollutants carried in the stream.

Reduction of B.O.D. of a plant waste usually requires a very costly installation, and here again smart management will attack the problem at its source in order to avoid unnecessary capital expense. A good example of this problem is the disposal of waste liquors from sulphite pulp mills. Treatment plants for adequate B.O.D. reduction are estimated to be nearly as large and costly as the pulp mills themselves. So the sulphite pulp industry is hard at work on possible process changes which will reduce the pollution problem without inviting economic disaster.

Biological treatment

Organic wastes can often be made non-polluting by bacterial decomposition. Type of treatment can be aerobic or anaerobic, depending upon whether the digestion is done in the presence or absence of oxygen. In aerobic processes, carbon is ultimately converted to carbon dioxide and hydrogen to water. Methane is the chief product of the anaerobic process, and it sometimes can be recovered for its fuel value.

Biological treatment is adaptable to almost all organic wastes except those containing ions which would be toxic to the bacteria involved. The presence of copper, nickel, chromium, mercury, and cyanides would be harmful to a biological treatment system.

Aerobic vs anaerobic

Choice between aerobic and anaerobic treatment depends upon a number of considerations. Probably the most important is the B.O.D. concentration. For dilute liquid wastes, aerobic treatment on trickling filters is usually indicated. Inasmuch as anaerobic treatment requires digestion in closed tanks, it is primarily limited to concentrated wastes, such as sludges removed from the main effluent proper (see p. 126).

Biofilter described

A trickling filter consists of a bed of stone, coke, or other reasonably hard and insoluble material placed over a large surface composed of drainage tile or other liquid-collecting system. The stone is usually sized from 2 to 4 in. and should be of a variety that fractures unevenly. The shape of the bed in plan may be square, rectangular, or round. Depth is generally between 5 ft. and 8 ft. Stationary distributors are used for square and rectangular filters, while rotary distributors are used with round filters.

Over-all size of a trickling filter is determined by the amount and concentration of wastes which it is designed to treat. A common rating on domestic sewage is 45 gpd. per sq.ft. Another index of size is a loading rate of 0.5-0.8 lb. B.O.D. per day per cu.yd. of stone.

The functions of the filter are (1) to pro-

The bugs love it

vide a medium upon which the purifying bacteria can grow and multiply; (2) to supply oxygen for their use in oxidizing organic matter; and (3) to provide an ample nutrient supply for the bacteria. The liquid waste is sprayed continuously or intermittently at a controlled rate over the surface of the filter. As the liquor travels slowly downward over the particles of stone, which become coated with active biological film, the organic matter is partly flocculated and absorbed by the film, and partly oxidized through the activity of bacteria and other organisms in the presence of air.

Suitable bacteria are always present in raw and settled sewage, and it is necessary only to provide them with the proper conditions to carry out their functions. Wastes originating in chemical processes will probably be sterile; inoculation with sanitary sewage will be required to put a biofilter into operation. Industrial wastes may also be deficient in certain nutrients which are essential for proper bacterial action, notably phosphorus and nitrogen. Domestic sewage is usually well fortified with these; addition of sanitary wastes to an industrial waste treatment plant might be entirely practical. Where industrial wastes are treated alone, addition of nutrient chemicals may be desirable.

The almighty dollar

In general, biological waste treatment involves a high investment and a low operating cost. Industrial wastes which are free from acids, grease, and floating scum can be handled satisfactorily by municipal treatment plants. The high capital cost for an industrial waste treatment plant might be reduced by arranging with the municipality to share the cost of operating the municipal plant in accordance with the volume of industrial effluent handled, or some other equitable arrangement. The municipality will likely be willing to carry the incremental investment required at a rate of return considered quite modest by usual chemical industry standards. Or, it might be possible that several neighboring industries could jointly erect and operate a common treatment plant on such a basis of division of cost.

The estimated cost of an industrial waste treatment plant published recently was $135,000 per ton B.O.D. removal per day. Operating cost, including depreciation, was estimated at $23 per ton of B.O.D. removal. This plant was designed for treating 175 gpm. of effluent with two ½-acre trickling filters.

Chemical oxygen deficiency

Another type of oxygen deficiency in streams may be caused, not by the presence of organic matter, but by chemicals in their reduced states. Examples are ferrous salts, thiosulphate, and sulphites. Treatment in these cases consists of converting the offending chemicals to the oxidized state. Aeration by spraying or by blowing through porous bottom tanks may do the trick, or possibly chlorination will be required. The specific problem will require a specific solution, but it can be handled like any normal chemical engineering job.

Colored wastes may or may not be objectionable chemically or biologically, but even so, good public relations demands adequate control of the disposal of colored wastes. The most satisfactory control is good dilution. This might involve any of the methods suggested earlier in this article. If sufficient dilution is impossible, the color bodies may have to be removed by precipitation or adsorption, or by conversion to non-colored compounds by chemical or biological means. In many cases, color will be associated with a pH or B.O.D. condition which will determine the required type of treatment. Chlorination or ozonation may be indicated. Here again, each problem is unique, but the usual chemical engineering techniques apply.

Toxic wastes

Finally, the toughest and most critical pollution problems are those concerning wastes containing toxic chemicals, such as cyanides, copper, arsenic, and even organics like aniline and acrylonitrile. Even if stream flow is sufficient to carry away the waste with good overall dilution, you must be extremely cautious in the way toxic wastes are introduced into the stream. Care must be taken to avoid even small zones where concentration might be lethal to fish and marine organisms. One of the greatest pollution hazards with toxic wastes is the possibility that they might destroy the bacteria which normally serve to purify the stream.

Alter or remove

The safest bet in handling toxic wastes is to render them non-toxic by change in chemical composition, or to remove them entirely. Cyanides can be treated with ferrous sulphate to form ferrocyanide. The latter is not as lethal as the cyanides, but is highly colored and may be objectionable on this basis. Cyanides can be converted also to harmless cyanates by treatment with sodium or calcium hypochlorite. Toxic metals can be removed by precipitation or ion exchange, but costs are high. In some cases recovery of metals can be made economically attractive on the basis of the value of the material recovered. A great deal of study is being given to use of ion exchange in treatment of brass mill wastes.

In conclusion, it is well to repeat that waste disposal problems must be approached on an individual basis. The purpose of this article has been, not to provide specific instructions as to how to solve pollution problems, but to bring to the attention of the chemical engineer some of the various techniques involved. Solution of actual problems requires, in many cases, the bringing to bear of as much engineering talent as can be obtained.

New Unit for Floating Light Solids

Diffused air helps

A new technique for removing difficult-to-settle solids and immiscible liquids was described in last month's issue of *Chemical Engineering* (pp. 107-110). Employing air to assist in floating particles to the surface of the liquid, it accomplishes the desired result without the use of reduced pressure. The secret lies in the method of dispersing innumerable tiny air bubbles throughout the liquid.

The unit can handle comparatively high flow rates, normally around 3 gpm. per sq. ft. of tank area, and up to 6 gpm. with excellent removal in some cases. It is a development of F. S. Gibbs, Inc., Boston, Mass.

What Process Wastes Cause Air Pollution?

Atmospheric contamination is a growing problem that demands recognition and determination of the pollutants.

LESLIE SILVERMAN, Department of Industrial Hygiene, Harvard School of Public Health, Boston, Mass.

Probably the most difficult part of the task of describing the nature of air pollution is actually to define it. We all recognize that the so-called normal atmosphere which surrounds us contains a large number of contaminants, many provided by nature, and others from man-made sources. For practical purposes, we usually consider that pollution is an excessive or unusual contamination by any normal or abnormal constituent. We may have natural fog—a type of pollution caused by an excess of a normal component, water vapor; and we may have a fog created by or largely composed of nucleii from zinc chloride—a man-made situation.

What is a nuisance?

A recent committee on air pollution of the American Medical Association[1] has attempted to define air pollution as an excessive concentration of foreign matter in the air which adversely affects the well-being of the individual, or causes damage to property. Pollution, in most situations, does not cause injury to health, but it may cause indirect annoyance by the presence of an abnormal material or concentration which creates a condition often described as a nuisance. The word "nuisance" involves legal terminology which has been bandied about the courts for many years without any successful definition—except that each case is apparently handled on its own merits. What constitutes a nuisance in one situation may not be a nuisance in another. The factors under which a situation is called a nuisance depend considerably on many human as well as physical factors, and it still remains a problem actually to determine where and when a nuisance exists.

Not necessarily industrial

Air pollution may be a problem which affects only those in the immediate vicinity of a single plant or group of factories. However, it can be a general condition which is completely divorced from industrial operations and results from home heating or incineration operations. In fact, it has been recognized that a major source of air pollution in English cities exists from open fires and poor home heating systems. A large percentage of the solid fuel burned in England is consumed in dwelllings. Hence, it must be recognized that this portion of the solid material and gas from combustion of fuels is non-industrial in origin.

Air pollution may exist as a general community problem, such as the "smog" in Los Angeles. To it there are many contributors, ranging from industrial operations and transport vehicles, to the incineration of rubbish and waste by individuals. Pollution may not necessarily be of any consequence to human health, but may be in such amounts that it causes damage to vegetation or to cattle indirectly through their absorption of the plant. Industrial fluorosis of cattle is attributed to the absorption of fluorine by growing crops. Unfortunately, vegetation concentrates the fluoride, and when the cattle eat these plants they receive a dosage which is far greater than they or individuals exposed would obtain by inhalation. In many situations vegetation is much more sensitive to air pollutants than man, and as such it serves as an early indicator of pollution. Levels of sulphur gases below those having effects on man will "burn" crops.

In addition to biological sensors of small amounts of air pollution we have physical damage from low levels of pollutants. Book-bindings, especially those of rare books, are adversely affected by very low concentrations of sulphur dioxide. These concentrations of SO_2 are far below those that would affect man or vegetation. Nevertheless in libraries housing rare book collections it has been found absolutely essential to adsorb the gas.

Harm without irritation

Atmospheric pollution conditions which do not create irritation for individuals or deposition in local areas can still be problems for communities. Such examples are the loss of visibility or sunlight which have been studied at length in England. If an appreciable loss of sunlight occurs, the population is deprived of a certain amount of anti-rachitic radiation. Visibility loss results in a reduction of sensory perception, lost time and accidents. Such losses may be traced to condensation nucleii created from certain industrial operations.

In any instance, it can be seen that the pollution problem ranges from gases and vapors to particulate matter from microscopic to macroscopic sizes.

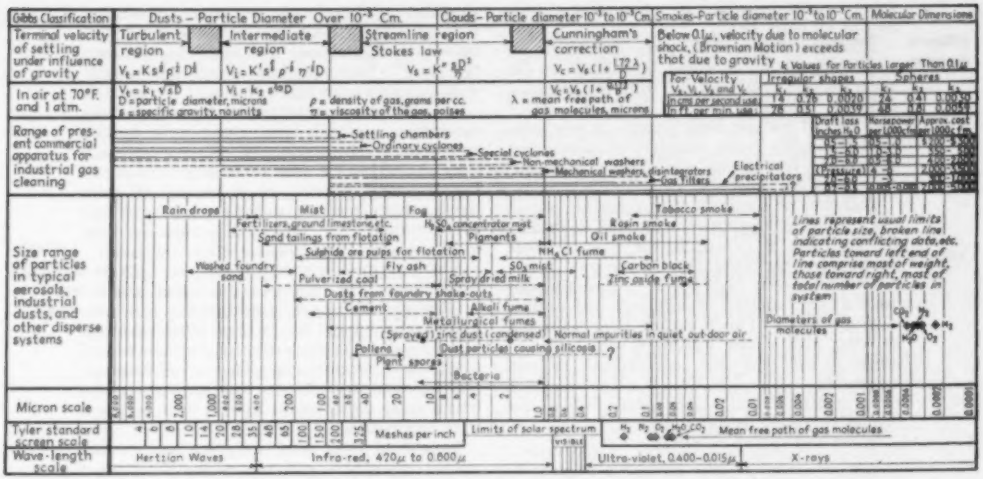
There are many legal aspects to air pollution, and it is not intended in this discussion to become involved in their consideration. However, certain legal situations may arise in which it is necessary to make determinations of the degree of atmospheric pollution and also the extent of emission from a given industry.

In summary we may say that many of our air pollution problems today are the result of sins of emission, rather than omission. While this paraphrase has been stated before, it might also be added that there are still sins of omission of collection equipment, which result in emission problems.

Types of pollutants

As mentioned above, air pollution problems involve a wide gamut of contaminant exposures in communities or around plants. These contaminants may be classified as:

A. Gases and vapors
B. Particulate matter
   1. Dusts
   2. Fumes


Gibbs Classification
Dusts – Particle Diameter Over 10⁻² Cm.
Clouds – Particle diameter 10⁻³ to 10⁻⁴ Cm.
Smokes – Particle diameter 10⁻⁴ to 10⁻⁷ Cm.
Molecular Dimensions
Terminal velocity of settling under influence of gravity
Turbulent region
Intermediate region
Streamline region
Stokes law
Cunningham's correction
Below 0.1 μ, velocity due to molecular shock, (Brownian Motion) exceeds that due to gravity
In air at 70°F. and 1 atm.
D = particle diameter, microns
s = specific gravity, no units
ρ = density of gas, grams per cc.
η = viscosity of the gas, poises
λ = mean free path of gas molecules, microns
Range of present commercial apparatus for industrial gas cleaning
Settling chambers
Ordinary cyclones
Special cyclones
Non-mechanical washers
Mechanical washers, disintegrators
Gas filters
Electrical precipitators
Draft loss inches H2O
Horsepower per 1000 cfm
Approx. cost per 1000 cfm
Size range of particles in typical aerosols, industrial dusts, and other disperse systems
Rain drops
Mist
Fog
Tobacco smoke
Fertilizers, ground limestone, etc.
H2SO4 concentrator mist
Rosin smoke
Sand tailings from flotation
Pigments
Oil smoke
Sulphide ore pulps for flotation
NH4Cl fume
Washed foundry sand
Fly ash
SO3 mist
Carbon black
Pulverized coal
Spray dried milk
Zinc oxide fume
Dusts from foundry shake-outs
Cement
Alkali fume
Metallurgical fumes
(Sprayed) zinc dust condensed
Normal impurities in quiet, out-door air
Pollens
Dust particles causing silicosis
Plant spores
Bacteria
Lines represent usual limits of particle size, broken line indicating conflicting data, etc. Particles toward left end of line comprise most of weight, those toward right, most of total number of particles in system
Diameters of gas molecules
Micron scale
Tyler standard screen scale
Meshes per inch
Limits of solar spectrum
Mean free path of gas molecules
Wave-length scale
Hertzian Waves
Infra-red, 420μ to 0.800μ
Ultra-violet, 0.400–0.015μ
X-rays

Properties of some typical aerosols from industrial and other sources (after C. E. Miller[2]).

3. Smokes
4. Mists

In a recent bulletin[1] the writer has presented definitions for the above materials that are generally accepted today by industrial hygienists and those interested in the nature of air pollutants.

Gases vs. vapors

Gases are normally fluids which occupy the space of the enclosure and can be liquefied only by the combined effect of increased pressure and decreased temperature, e.g., oxygen, hydrogen and nitrogen. Vapors are the evaporation products of substances which are liquid at normal temperatures. Vapors (e.g., benzene, or mercaptans) behave similarly to gases.

Dusts, fumes and smoke are distinguished from each other by their mode of generation and their particle size. Dusts are formed from solid inorganic or organic materials reduced mechanically in size by processes such as crushing, grinding, drilling or blasting. These particles range in size from the visible to submicroscopic, but in air sampling usually only those below 50 microns (50 μ) are found, because only these remain suspended in air for a significant period.

Fumes vs. smokes

Fumes are formed from solid materials by processes such as combustion, sublimation and condensation. For example, zinc vapor will evaporate from the surface of heated liquid metal and will then condense upon contact with room or outdoor air and form small fluffy particles of zinc oxide. Fumes are usually less than 1 μ in size, although they may flocculate and form larger particles. Smokes are considered as the products of combustion of solid materials that are organic, such as wood, coal, oil or resins. The size of smoke particles is usually less than 0.5 μ.

Mists are produced by atomization of liquids, condensation from liquids in gaseous states or entrainment of liquids by gases evolved from industrial processes. In size, mist particles range from 0.1 μ to 25 μ. For example, mists are usually evolved industrially from solutions of acids or alkalis which boil at temperatures above 100 deg. F.

The above classifications of atmospheric pollutants are presented because the methods employed for air sampling depend considerably upon the nature and particle size of these materials.

Wide range of problems

These contaminants, of course, range from molecular to macroscopic sizes. Pollution problems with which the writer has been concerned recently have ranged from coarse cinder particles allegedly blown off storage piles for cinder block manufacture, through fibers resulting from cotton waste handling processes, down to the exposure of individuals to odors emanating as trace vapor constituents from nearby chemical operations.

One of the most serious situations existing today is the incorrect concept that all air pollution is harmful to health, and that all process effluents fall in this category. Actually this is not the case, except in unusual circumstances where meteorological and topographical conditions permit concentrations to rise to irritating levels.

Character determines pollutants

The problems arising from process effluents depend upon the nature of the pollution. Nuisances may be created by settling, or settled dusts, in which case coarse particles are of major concern. On the other hand, the problem may be staining or discoloration of surfaces, in which case, it may be caused by colored, opaque, or sooty particles. Discoloration may also result from reaction with painted surfaces, such as occurs when hydrogen sulphide or sulphide gases react with lead paints. Deterioration of building stones has been observed with prolonged exposures to sulphuric acid mists in city air. Obscured vision is often due to fine mists or smokes. Acrid, irritating or unpleasant odors often result from mist, gas, smoke, or

vapor emanations which do not present a problem in visibility loss.

Effluents are many

Effluents from various processes are so extremely numerous it would be difficult to list them all and still keep up with the chemical industry. The chart devised by C. E. Miller[4] and revised for use here presents a few common pollutants, giving examples of particle size and range for general atmospheric pollutants from chemical processes.

Pollution problems in large cities, of course, come from a conglomerate mixture depending on the types of industries, the type of home heating, and the topography and terrain. Those cities located near "dust bowls" or desert regions have a large amount of inorganic and organic dust in the air. This is carried from fields and growing plants, and usually a wide variation exists in the type and concentration of contaminants.

In terms of total weight concentration, the figures below are usually found:

Rural and suburban districts
0.4 to 0.8 mg. per cu. m.

Metropolitan districts
0.9 to 1.8 mg. per cu. m.

Industrial districts 1.8 to 3.5 mg. per cu. m.

The mean particle size of these contaminants is usually less than 0.5 μ. In content they contain a variety of substances such as pollen, fly ash, carbon, lint, silicate and silica dusts.

Metals in dusts

Many industrial metals such as iron, lead, zinc, copper and cadmium have been identified in city atmospheres; rubber from tires, and even such trace elements as beryllium have been found where no beryllium refining or handling operation exists. The latter anomaly can be attributed to the presence of beryllium in many coals. A recent study by the American Air Filter Co.[5] on the nature of dust in city air in Chicago and Pittsburgh indicates a large difference in the kind of carbon analysis. It is recognized that the sooty or discoloring property of general atmospheres in large cities is due to free carbon, whereas complete incineration of a collected sample of settled dust would ordinarily indicate total carbon from carbonates, and combustible materials.

There are other problems in connection with general city atmosphere which could be discussed at length, but since these problems are essentially concerned with air conditioning and home ventilation, they will not be considered further.

In many situations near certain industries specific contaminants can be identified in connection with industrial operations, and these become problems for the plant chemist, other investigators or pollution control authorities to appraise.

Approaches to evaluation

Pollution evaluation properly should be divided into two approaches: one which might be considered as determination of pollution sources and their magnitude; and the other as measures of dispersion and area contamination.

Since pollution by industry can be traced to process losses or effluents it is essential that any study of the problem begin at this point. Thus stack dissemination or discharge from particular operations should be the item that overshadows all other studies in air pollution. Basically, stack or effluent evaluation is easier to handle because concentrations are much higher and the samples have not been diluted and mixed with materials from other sources.

The actual determination of stack or process emanations essentially forms a part of the intrinsic chemical engineering of most operations, since it necessarily involves material balance. Unfortunately in many cases amounts of materials which produce pollution problems do not represent any substantial economic loss to the operator, and thus are often overlooked.

Sampling at the stack

The mechanics of stack sampling has recently been discussed at length by the writer[6] and it is intended here to simply outline the principal factors involved and the types of devices which may be applied to the problem. In many cases continuous automatic sampling or monitoring may be a worthy addition for chemical industries having acute situations that require constant supervision.

Expanding from stack sampling to area or general atmospheric pollution evaluation is necessary when the former is inadequate or nonrepresentative of plant conditions.

The principal factor to be kept in mind when sampling from stacks or processes is that the sample should be representative. For this purpose it is essential that aliquots withdrawn from ducts or stacks should be obtained iso-kinetically. It is usually necessary to make a preliminary velocity traverse or air flow determination to obtain the correct sampling rate. Special stack sampling heads have been devised for obtaining results under iso-kinetic conditions. These heads incorporate static and impact pressure measuring devices, and by adjustment it is possible to withdraw samples under correct velocity conditions. However, these devices still require preliminary velocity traverses. Because newer anti-pollution codes are based on hourly emission rates it is necessary to obtain total flow for final weight calculation from the stack effluent concentration.

Sampling devices

Since the nature of effluents varies from gaseous to solid materials, a wide variety of devices is necessary for collection of samples. Many of these devices are small-scale units based on the same principles used to control process effluents. In obtaining stack samples it is desirable wherever possible to locate the sample collection device as close to the point of contamination as possible. This technique eliminates the need for cleaning or washing out the sampling head and connecting tubing. Of course, this cannot always be done, and in the case of gases and vapors it is much more difficult. In some instances adsorbents in the form of cartridges can be placed in the sampling head if desired.

Gases and vapors in stacks are collected by means of a stack sampling head with a long tapered nose. Certain high temperature and saturated gas conditions may need a heated nozzle and connecting tubing to prevent condensation before the chosen collecting device. For gases this may be an absorber such as a small packed column wetted with an absorbing agent, or it may be a sintered metal or glass

absorber immersed in an absorbing solution. An impinger or gas washing bottle can be used for readily absorbed gases. Adsorbents such as activated charcoal, silica gel or activated alumina can be used for some gases and vapors. Absorbents in the form of dry solid chemicals such as soda lime for acid gases can be used in some instances. These can be weighed, or the collected material may be determined by chemical methods. In certain cases condensation devices can be used for condensable gases and vapors with low vapor pressures.

Particle collectors

The collection of particulate material requires a device which is efficient for removal of particles of the size discharged. The equipment used may depend upon inertial or centrifugal principles, such as impingers, impactors or small cyclones. The first two named are satisfactory for particles or mists down to 1 μ in size, whereas the cyclone will not give effective removal below 5 μ. For weight evaluations, however, the cyclone may be satisfactory if the effluent should range between 1 and 10 microns, since the largest particles in this range weigh 1,000 times the smallest particles.

For all ranges down to 0.2 μ and less, filtration devices such as paper or glass thimbles, or wool bags, give satisfactory results. The medium selected depends upon temperature and corrosion conditions. In our field work we have used paper thimbles to temperatures of about 150 deg. C., and glass beyond this range. Our glass thimbles are fabricated from a sandwich consisting of two pieces of glass cloth and a layer of "AA" glass fiber (approximately 1.5 μ fiber size). Such filters can be used for certain acid mists, but in many cases these are best collected by small electrostatic precipitators. These are useful for mists and metal fumes, but require more elaborate equipment, such as a small high-voltage power pack. We have used a.c. voltage with approximately 15,000 volts for most inorganic dusts and some metal fumes, but d.c. high voltage is preferable since it eliminates shock hazards and has wider application. Sampling with precipitators integral with the head has also been used.

Light scattering also

The determination of stack effluents has also been made by means of photometric devices which depend upon light scattering by the suspensoid or particulate material. These units of course require calibration if conversion to weight is desired. They have been used for automatic control work, and when visibility or haze production is the problem they do not require any more than an empirical evaluation.

Most stack and process sampling can be done on a weight basis although in some cases where air or gas is to be recirculated, discoloration or optical methods, such as evaluation of filter stains or Tyndall beam scattering, can be applied. In extreme cases actual particle enumeration can be performed.

Neighborhood sampling or general atmospheric pollution after dispersion from a source is a field for the air pollution analyst. Many collection devices have been applied and these the writer has described in detail elsewhere[4].

For nuisances such as settled dusts, sedimentation cells or settling pans are employed. Staining or sooting are usually assayed by discoloration of filter papers or special painted surfaces. Gases and vapors can be sampled by the units used for stack collection, but much larger air volumes and more sensitive analytical procedures are necessary because of the tremendous dilution—from grains per. cu. ft. to grains per 1,000 cu. ft., or percent concentrations to parts per million. Odor problems may require special testing equipment and trained observers as no simple procedure has yet been devised to solve many odor situations in any but a sensory way.

Collection for study

For collection of particulate material for weighing, identification and counting, impingement, filtration, or precipitation (thermal and electrical) procedures have been utilized depending upon the nature of the contamination. We have used high-volume filtration devices[5] with success and can evaluate weight and discoloration, and perform identifications, both microscopic and chemical, on the same sample.

Because of the wide variety of contaminants encountered, no analytical procedures are detailed here. For this the reader is referred to Ref. (4) by the author. This bulletin includes an extensive bibliography for many contaminants. The recent Stanford Research Institute publication in which Ref. (5) appears also has useful information along these lines.

The plant operator may find it necessary at times to add a "tracer" to his effluents to determine if he is the source of contamination. Many procedures can be employed, such as the use of certain metal ions or fluorescent materials, or possibly very dilute radioactive isotopes with short half-lives.

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Chlorine Dioxide for Odor Control

For 30 years rather extensive efforts have been made to use chlorine gas in the deodorizing of offensive gaseous discharges from organic matter, for example, from rendering plants. Most such installations seem to have been abandoned. Now, however, through work of Mathieson Chemical Corp., it appears that a satisfactory process has been developed, using a combination of chlorine and chlorine dioxide. Within a few months, after tests, we expect to be able to present results attained in a full scale plant.

Equipment is simple

By reaction of an excess of chlorine water with sodium chlorite solution, a solution containing Cl_2, ClO_2 and NaCl is obtained. Vapors from the cookers are then drawn through a suction tee into a water line discharging to a 10,000-gal. tank. Here make-up water containing Cl_2 and ClO_2 is added. Water from the tank is then recirculated to the absorption system.

When Wastes Go up the Stack

Both weather conditions and local topography have a marked effect on ability of stacks to disperse aerosols.

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Meteorology is the study of the phenomena of the atmosphere, especially those that relate to weather. Hence, meteorological control of air pollution is the study of the effects of such phenomena as wind and temperature effects, on the dispersal of gaseous discharges into the atmosphere.

"A sea of gases"

The atmosphere may be considered as a sea of gases filled with changing currents which give it an infinite capacity for dispersing the polluting gases discharged by industry.

However, just as the discharge of industrial wastes into streams and rivers may exceed the rate of dilution and dispersion in these bodies, so may local meteorological conditions affect the dispersal of gaseous wastes, causing occurrence of excessive and dangerous concentrations of gases.

Most industrial waste gases are discharged from some type of stack. In order to predict the rate of dispersion of polluting gases, it is important to consider the interrelation of stack height, rate of gaseous emission, meteorological conditions and topography, and their effects on gas concentration at ground level.

The weather plays a tremendously important part in the observed effects of air pollution. Windy, dry and gusty days are perfect for the rapid dispersion of gases in the atmosphere. Calm, moist days and particularly those where there is a strong temperature inversion (see below), are the worst days for the disposal of industrial wastes. It is precisely this type of day that makes the public aware of air pollution.

Gases form a cone

When gases are discharged into the atmosphere continuously, they tend to spread out in the wind in the form of a cone, the dimensions of which are determined by the turbulence of the gas stream.

In still gases, kinetic diffusion is the controlling factor. However, in turbulent gas streams, eddy diffusivity controls. The tendency for eddy diffusion of materials increases with increasing turbulence.

In discussing the dispersal of gases and dusts discharged from a point source into the atmosphere, we are primarily concerned with the value of eddy diffusivity. Without going too deeply into the theory, we can define eddy diffusivity as being related to the rate at which the concentration of a substance in one mass of fluid will tend to equilibrate itself with the concentration in another mass of fluid at a finite distance away. The coefficient of eddy diffusivity K is proportional to the average velocity component of the masses along a given plane, and to the distance between them. Thus, in the direction of the wind, $K_x \propto u_x$; cross-wind, $K_y \propto u_y$; and vertically, $K_z \propto u_z$.

Based on this concept, Bosanquet and Pearson[1] derived their well known formula for determining the concentration of a gas cloud that is being continuously discharged from a chimney, at any distance from the point of emission of the gases.

$$C_a = \frac{W}{\sqrt{2\pi}\, p\, q\, u\, x^2}\, e^{-a} \qquad (1)$$

where $$a = \left(\frac{h}{p\,x} + \frac{y^2}{2\,q^2\,x^2}\right) \qquad (1a)$$

What causes turbulence

Turbulence is engendered in a fluid stream by two factors. The first is the passage of the fluid over a surface at such a rate that the forces of motion are greater than the resistance to shear of the fluid particles (its viscosity). This results in each adjacent portion of the fluid having a relatively different velocity. The roughness of the surface over which the fluid flows will also influence the breakdown of the cohesive forces.

The second factor in inducing turbulence is the introduction of a velocity component at a direction other than the direction of flow. This secondary velocity component may be caused by either roughness, a change in density because of heat transfer, or some other physical phenomenon.

Bosanquet equation

Bosanquet's equation is based on the definition of diffusivity caused by turbulence resulting from the motion of a fluid over a surface. However, in atmospheric phenomena close to the earth, another factor will affect the air turbulence, namely, the stability of the air structure. This may be explained as the tendency for a portion of air to remain in a horizontal plane and to resist upward displacement.

NOMENCLATURE

(Any consistent units, such as those given.)

- a = Group defined in text.
- b = Group defined in text.
- C = Concentration at point (x, y, z), lb./cu. ft.
- C_o = Ground level concentration of pollutant, lb./cu. ft.
- c_y = Horizontal diffusion coefficient, ft.$^{n/2}$
- c_z = Vertical diffusion coefficient, ft.$^{n/2}$
- d = Group defined in text.
- e = Base of natural logarithms = 2.71828 +.
- h = Stack height, ft.
- K = Coefficient of eddy diffusivity.
- n = Number ranging from 0 to 1.0, depending on atmospheric stability; a value of 0.25 is neutral, 0.33 is mild inversion, 0.5–0.6 is strong inversion.
- p = Diffusion coefficient in vertical direction, ranging from 0.05 to about 0.12; usually can be taken as 0.07.
- q = Diffusion coefficient in horizontal direction; can ordinarily be assumed equal to p.
- u = Mean wind velocity, ft./sec.
- W = Mass rate of emission of pollutant from stack or ground level source, lb./sec.
- x, y, z = Coordinates with origin at base of stack, respectively down-wind, cross-wind and vertical, ft.

The magnitude of this tendency is described as the lapse rate.

Adiabatic lapse rate

Normally, a gas that is free to expand will tend to move from a region of higher pressure to one of lower pressure. As it does this, it will expand, and if there is no interchange of heat with the surroundings it will become cooler. One would expect that as one went higher into the atmosphere and the pressure decreased, that there would be a corresponding drop in temperature. The rate of decrease in temperature with increasing height, assuming no loss of heat, is known as the adiabatic lapse rate. It amounts to about 0.6 deg. C. per 100 meters for dry air, and about 0.4 deg. C. per 100 meters for saturated air.

Let us examine, by means of a few examples, how the lapse rate effects the stability of the air mass. As the first example, assume that the measured lapse rate, as determined by atmospheric soundings, is equal to the theoretical lapse rate. If we take a portion of gas at equilibrium at sea level and carry it adiabatically 100 meters upward, its temperature will drop 0.6 deg. C. The density of this portion will exactly equal that of the surrounding air at the new elevation since we have determined that the measured lapse rate is equal to the theoretical. Consequently, the masses of air as they are displaced upward or downward will be in equilibrium with their new surroundings and there will be no tendency for further motion vertically. This lapse condition is known as "neutral."

Unstable condition

If, however, the measured lapse rate is greater than the adiabatic, what will happen? Now let us assume that actual temperature readings show sea level temperature to be 70 deg. C, and at 100 meters altitude, a temperature of 69 deg. C. If we take a mass of air at sea level and carry it up adiabatically to 100 meters, its theoretical temperature should be 69.4 deg. C. This is 0.4 deg. C. higher than its surroundings, so that the density of this hypothetical portion of air will be less than that of the surrounding air, and its natural tendency will be to rise higher. Such a lapse condition is "unstable," and produces a vertical velocity component. Such instability of the atmosphere tends to increase its turbulence and consequently its capacity to absorb polluting gases.

Temperature inversion

It is obvious, then, that if the measured lapse rate is less than the adiabatic rate, a "stable" condition results in which the gas mass, if displaced vertically upward, would tend to return to its original lower altitude. An extreme example of this condition is when a temperature inversion occurs. Here the ground temperature is actually lower than the air above it.

From experimental data on the dispersal of aerosols and gases at ground level, this effect of air stability on diffusion was found to be quite noticeable. On the basis of such experimental data, Sutton[6] derived the following formula:

$$C = \frac{W}{\pi\, c_y\, c_z\, u\, z^{2-n}}\, e^{-b} \qquad (2)$$

$$\text{where } b = \left(\frac{y^2}{c_y^2\, z^{2-n}} + \frac{z^2}{c_z^2\, z^{2-n}}\right) \qquad (2a)$$

He then derived a formula for the concentration

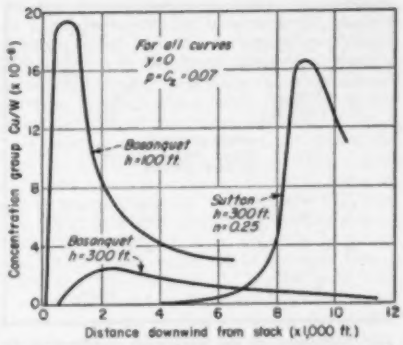

Fig. 1—How ground level concentration varies with stack height and distance down-wind.

of gases at any point of distances x, y, and z from the base of a chimney of height *h*. When this equation is solved for the concentration of a gas at ground level ($z = 0$):

$$C = \frac{2\,W}{\pi\, c_y\, c_z\, u\, z^{2-n}}\, e^{-d} \qquad (3)$$

where

$$\text{where } d = \left(\frac{y^2}{c_y^2\, z^{2-n}} + \frac{h^2}{c_z^2\, z^{2-n}}\right) \qquad (3a)$$

It may be noted that this equation is similar in form to Sutton's experimentally derived equation (Eq. 2), where the gaseous discharge occurs at ground level. However, the concentration at ground level is shown by Eq. (3) to be twice as great when the discharge occurs from a chimney.

Maximum concentration

If we solve both Bosanquet's and Sutton's equations for the distance down-wind at which maximum concentration occurs, we obtain the following equations:

$$x_{max.} = h/2\,p \text{ (Bosanquet)} \qquad (4)$$

$$x_{max.} = (h^2/c_z^2)^{1/(2-n)} \text{ (Sutton)} \qquad (5)$$

Similarly, for the maximum concentration:

$$C_{max.} = \frac{4\,W}{\sqrt{2}\,\pi\, e\, u\, h^2} \cdot \frac{p}{q} \text{ (Bosanquet)} \qquad (6)$$

$$C_{max.} = \frac{2\,W}{\pi\, e\, u\, h^2} \cdot \frac{c_z}{c_y} \text{ (Sutton)} \qquad (7)$$

Agreement with practice

The accuracy of these equations was checked by Thomas, Hill and Abersold[7] who compared them to data obtained from smelters in the San Francisco Bay area. They found reasonably close agreement between observed data and results calculated from Bosanquet's equation. The data deviated considerably from results calculated by the use of Sutton's equations when average values of *n* were used. If $n = 0$, then the predicted results agreed more closely with experimental data although not as closely as when Bosanquet's equation was solved. From this, Thomas and his associates concluded that there was a negligible effect of lapse conditions—as used by Sutton as an exponential correction—on the rate of dispersal from tall stacks. This is substantiated by meteorologists[4] who have observed that turbulent effects on local diffusion, caused by lapse changes, decrease rapidly with

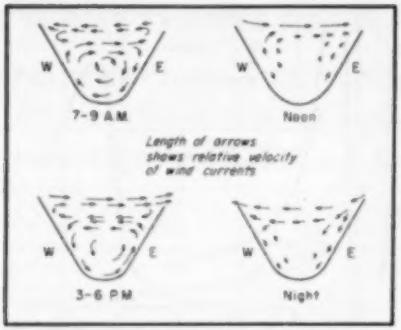

Fig. 2—Progress of the sun causes variations in air currents in a valley, polluting gases being carried to the valley floor in morning and evening.

Maximum Allowable Sulphur Emission at Trail, Tons per Hour

		Turbulence* 0-74		75-149		150-349		350 and up
		Wind Conditions†						
Time	Season	*A*	*B*	*A*	*B*	*A*	*B*	*A or B*
Midnight to 3 a.m.	Growing	2	6	6	9	9	9	11
	Non-growing	2	8	6	11	9	11	11
3 a.m. to 3 hr. after sunrise	Growing	0	2	4	4	4	6	6
	Non-growing	0	4	4	6	4	6	6
3 hr. after sunrise to 3 hr. before sunset	Growing	2	6	6	9	9	11	11
	Non-growing	2	8	6	11	9	11	11
3 hr. before sunset to sunset	Growing	2	5	5	7	7	9	9
	Non-growing	2	7	5	9	7	9	9
Sunset to midnight	Growing	3	7	6	9	9	11	11
	Non-growing	3	9	6	11	9	11	11

* Number of velocity changes per ½ hr. † *A* = Unfavorable and *B* = favorable conditions of wind velocity and direction.

height above ground. The large-scale effects of lapse conditions on eddy diffusivity are already taken into account by the vertical and horizontal diffusion coefficients and the wind velocity.

However, for discharges close to the ground —below 200 ft.—indications point to the greater reliability of Sutton's equations.

Thus we can calculate the approximate concentration of gases at ground level by the use of these equations (or if aerosols are also emitted, by suitable modifications.[3] Fig. 1 shows how ground-level concentration varies with distance down-wind, for various stack heights. The chart emphasizes the different results obtained with the Bosanquet and Sutton equations.

Calculating an example

As an example of the use of these equations, let us calculate the height of a stack required to disperse 50 tons per day of SO_2 so that the maximum ground concentration will be 1 ppm. (0.0001 percent). By the use of Bosanquet's modified equation (Eq. 6), the stack height required with a wind velocity of 1 mile per hr. is 895 ft. At a wind velocity of 5 miles per hr., the stack height needed to obtain the desired ground concentration would be 400 ft. and with a 10 mile per hr. wind, the height needed would be 283 ft.

It is apparent from this discussion that one means of controlling air pollution at ground level would be to vary the rate of emission of waste gases with wind velocity, in accordance with predetermined calculations and observations.

In actual practice, however, the solution to the problem is not as simple as indicated. This is due to variations in topography and their effect on wind currents, and to large concentrations of industry in a comparatively small geographical area.

Effect of topography

The major topographical restriction on normal atmospheric diffusion comes from the presence of mountains and valleys. In most cases, industry gravitates to valleys chiefly because of ease of transportation, and sources of water for process and for disposal of water wastes. From the point of view of air pollution, this is an unfortunate choice because valleys act as funnels, carrying air streams for long distances substantially unchanged in shape and concentration. Under proper conditions, dangerous concentrations of polluting gases can build up easily and be carried to ground level where they will damage crops and health.

Experience at Trail

One very intensive investigation into the character of such pollution was carried out at Trail, B. C., and reported in a number of journals.[4, 5]

At Trail the various meteorological phenomena were magnified because tall mountains surrounded the smelter. These were some 2,-3,000 ft. above the top of the smokestack.

The troublesome fumigations (conditions resulting in a fume blanket at ground level) occurred as a result of daytime thermal effects in the valley during the growing season.

Smoke or gaseous discharges, from a chimney will rise almost vertically and then, under laminar flow conditions, spread out horizontally at a level where the density equals that of the surrounding air. During the night—as a result of ground radiation—a temperature inversion readily forms in a valley and a laminar flow of air down the valley is generated. If any polluting gases are discharged into this air stream, it is obvious that they will be carried down-valley substantially unchanged.

Thermal variations

As the sun rises in the morning, unequal thermal effects are started as a consequence of the sun heating the west slope. A cross-valley component to the valley winds is generated as the air along the west slope rises, flows across the valley at its equilibrium altitude in an easterly direction and, on cooling, tends to fall down to the valley floor along the east slope. This circulation is indicated in Fig. 2. If there are any polluting gases in the upper strata, it is obvious that the thermally induced circulation will carry them down to the valley floor.

This circulation will not continue indefinitely, as the sketches for later hours in Fig. 2 indicate. As the day progresses, the valley becomes uniformly heated and the transverse air currents become negligible. At the same time, the valley winds tend to reverse themselves and start to flow up-valley.

In the afternoon and evening, as the sun leaves the west slope, the ground tends to cool rapidly by radiation and again a differential thermal gradient is set up across the valley. A

transverse air current is set up, opposite to that occurring in the morning. Again, if there are any polluting gases, they will be carried to the valley floor. Along with this reversal of transverse air flow, the valley winds also reverse themselves and start flowing down the valley.

It is obvious that these daily thermal effects will occur more or less simultaneously down the valley and concentrations of polluting gases at these times will be substantially equal at different points along the valley.

Effect of inversions

Another type of fumigation occurs as a result of thermal effects which do not occur daily. These are known as "temperature inversions." They may occur as a result of ground radiation losses on clear nights, in which case the ground air becomes cooler than the upper air. Or they may occur when a cold air mass sweeps in under a warm air mass. The effect of stable atmospheric conditions is, in many respects, that of throwing a blanket over the region, thus preventing the escape of gases through natural convection currents.

The radiation-induced inversion is a fairly common phenomenon and on such "heavy" days, we become very much aware of the variety and type of industry surrounding our communities. Atmospheric dispersion of urban air pollution is difficult since it is an accumulation from many sources. It requires the cooperation of both industry and the public to minimize the discharge of polluting gases of all types—from home furnaces, from city dumps, as well as industrial wastes. We must remember that burning city dumps and household heating units have been found to contribute as much, or more, to the community dirt and odor problem as do the local industries. It is under such conditions that control by meteorological studies falls down and we must turn to mechanical, physical and chemical means for preventing the discharge of polluting gases and dusts.

Problem at Los Angeles

The Los Angeles area is an unusual one from a meteorological standpoint. Here, the temperature inversion is caused by masses of cool air which sweep down under the tropical maritime air masses that blanket the California coast. The resulting stable air mass combines with the action of the backdrop of mountains to form a perfect pocket from which polluting gases find it substantially impossible to escape.

Where a plant is located on flat terrain, or is in a valley as at Trail, the coordination of daily operations with weather conditions is practical.

The basis of this control is first to determine an economic stack height by means of Bosanquet's or Sutton's equations. A study of average meteorological data for the region should be made to determine wind direction, wind velocity, wind turbulence and atmospheric stability. A correlation may then be made between rate of emission and expected ground concentration under various weather conditions. Such a regime was set up at Trail. The accompanying table illustrates how the rate of emission of SO_2 at Trail was varied with weather conditions. A similar regime could be set up for almost any single polluting source in a given area.

The table shows that turbulence is a major factor in determining favorable dispersion conditions. By turbulence is meant the number of times in which the wind velocity changes during a given interval of time. This thought falls in line with the theory discussed previously in which turbulent conditions were considered as those in which the relative velocities of adjacent portions of fluid were different.

Control based on weather

In locating a plant, consideration should always be given to the general weather conditions of a given locality, and to the location of the proposed plant site with respect to farms and towns, and their relations to wind direction.

Generally speaking, it is advisable to locate plants on the down-wind side of towns or farms. Since the prevailing winds change with the seasons, the choice of the prevailing wind to be considered would be that occurring during the growing season. It is then that the more adverse weather conditions, such as temperature inversion, are most likely to occur.

If a plant is one from which strong odors, or dusts, may be discharged, it should never be located in a valley or at the base of a hill on the top of which are residences or farms. Building a plant in such places is bound to bring the company into legal conflict with its neighbors.

I should like to mention one other method for control of air pollution, although it is not strictly meteorological in character. That one is the alteration of the composition of the harmful constituents in the waste gases before discharge.

Control by incineration

One process used for this purpose is incineration. The destruction of odors caused by combustible substances is often accomplished by passing the obnoxious gases through the flame of a burner. Small quantities of hydrogen sulphide, rendering plant odors, mercaptans, etc., have been made substantially innocuous in this way.

Instead of using the conventional combustion processes, methods have been developed recently for the catalytic combustion of these substances. One such method is to pass the obnoxious gases over a catalyst, such as heated platinum, in the presence of air.

Another method for altering the composition of the effluent gases is by chemical means. Acidic gases for example, have been passed through beds of alkaline substances such as lime.

Field surveys with devices such as electrostatic samplers (Mine Safety Appliances Co.) are often needed.

Sulphidic gases have been passed through beds of iron oxide, in which case the sulphides are removed by the iron to form ferrous sulphide.

To sum it up To summarize, the dispersal of industrial waste gases into the atmosphere may be safely accomplished by a combination of the following factors:

1. Proper plant location with due regard to prevailing weather conditions, topography and the surrounding neighborhood.
2. Determination by the use of Bosanquet's equation of the preferred stack height to be used to insure minimum gas or aerosol concentrations at ground level. (However, if short stacks are used, Sutton's equations will probably be more accurate. In this case the character of the plant's neighborhood must be carefully considered to be sure that no damage or annoyance to people will result from the plant's operation.
3. Control of the rate of discharge with daily local weather conditions to insure that the dispersal power of the atmosphere will not be exceeded.
4. Installation of proper control equipment so as to be able to meet the predetermined maximum emission rate.
5. Alteration of the type of discharge by incineration or by chemical means.

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Filters Aid At-Source Control of Dusts

Industrial filters take most of the load, but air-conditioning filters and new types for ultra-fine dusts are also in the picture.

W. O. VEDDER, Manager, Dust Control Dept., Pangborn Corp., Hagerstown, Md.

The problem of collecting air-borne solid pollutants at the point of their production is one that industry knows primarily as "dust control." Obviously, much more can be accomplished in elimination of public nuisance by preventing the discharge of aerosols from an industrial site, than by trying to cope with them after they are on the loose. This means that the control of dust at its source is a more useful method than the filtration of incoming air.

Filtration widely applied Of the many methods used for dust control, filtration is the one most widely applied to the collection of particulate matter in the size range from 50 microns diameter, down. This discussion deals solely with such methods.

Almost all of the equipment in wide use in this category is based upon the flow of air or gases through filtering membranes of cloth or felt. It is classified under the heading of cloth filters or collectors. For the ultra-filtration of aerosols there have recently been introduced paper-like and fibrous materials—some of them composed of synthetics, or coated with resins so as to take on surface electrostatic charges under the influence of air flow. These materials cannot be classed as filter cloths or felts, and may someday comprise a new category. Also among the filters are many of the air-conditioning types, which however make no claims of significant separation efficiencies with the dust loadings encountered in industrial applications.

Industrially practicable cloth collectors are useful far beyond the prevention of public nuisance—a fact which should be of enormous help to those concerned with pollution abatement in inducing industry to act on the problem.

Filtration objectives Dust collection equipment has the following main objectives: (1) To improve working conditions in the user's plant; (2) reduce material and product soilage and spoilage; (3) prevent dust from re-entering working atmospheres from the point of discharge; (4) permit recirculation of the clean air; (5) improve plant housekeeping and decrease building maintenance; (6) save wear and maintenance on operating equipment; and (7) collect valuable materials (in dust form) as primary production products, reclaimed raw materials or salvageable wastes with a use or sale value. Such dollars-and-cents advantages give an impetus to the control of air pollution on a purely economic basis.

Factors in collector selection Factors that influence collector selection include: (1) The properties and physical and chemical characteristics of the materials to be collected and of the conveying air or gas; (2) the amount of material to be collected per unit of time; (3) the temperature of the conveying air and of the conveyed material; (4) the amount of moisture; (5) the plant and collector location; and (6) whether the operation is intermittent or continuous.

Cloth filter systems are widely used in collecting finely divided, dry dusts at high recovery and economical cost. In all cases the build-up of a "dust pack" on the filter fabric assists in the filtration and in holding back the finer particles. This light dust pack or mat acts as a pre-coat and is formed in the first few seconds of operation of the filter. It helps materially to improve the over-all efficiency of the system. When the dust pack is shaken or rapped from

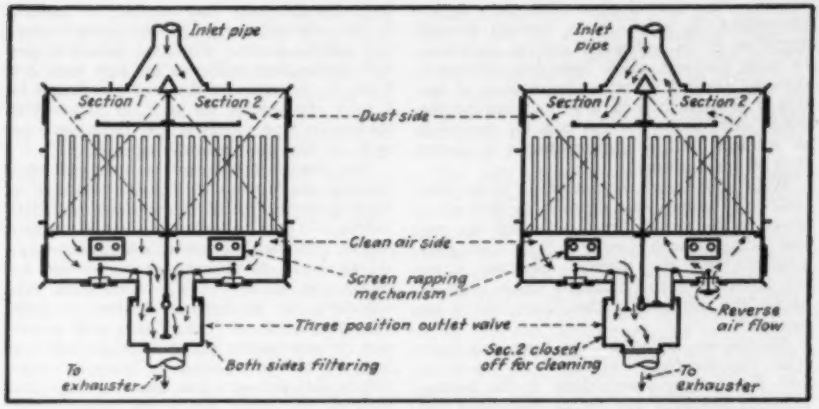

Fig. 1—Two-section continuous collector, at left both sections operating, at right, Section (2) cleaning.

the surface of the filter during the cleaning cycle the precoat should be left intact.

The location of the filter-fabric elements in the collector housing is important, and must be such that the coarser particles will drop from the air or gas stream by mere reduction of velocity upon entering the collector housing. Thus they are removed from the air stream before it passes through the filter fabric, reducing the load on the filters with consequent reduction of the cleaning problem.

Bag-type filters

Cloth filters are made in two general designs: the tube or bag type, and the cloth-screen type. In the first the filter fabric is formed into a series of tubes or bags, open at one end and closed at the other. These are vertically suspended in a casing with the bottom or open ends tightly sealed to thimbles in a plate located near the bottom of the casing. The dust-laden air enters the casing below the thimble plate and passes upward through the cloth cylinders. Bags and tubes vary in size from as small as 3 in. diam. to a foot or more. The larger sizes, up to 45 ft. long, are used in bag houses for the collection of oxide fumes. In bag and tube type filters, the dust is retained on the inner bag surface and the cleaned air continues on through the fabric to an outlet at the side or top of the casing. Tubes or bags are fitted with a shaking device, usually at the top, which is periodically operated to remove the dust pack and drop it to hoppers below.

Cloth-screen filters

The cloth-screen type of collector is a refinement of the tube or bag type, and of more recent design. The filter fabric is applied over a series of rectangular frames which effectively support the cloth preventing collapse under air load.

Fabric covers both sides and three edges of the frame with the fourth edge left open to form a flue or clean air outlet. Cloth-covered screen frames are installed side by side in the casing and so arranged that all air flow is through the fabric and out the open end of the frame. Open ends are sealed to each other or to a collector wall which divides the casing into a dirty (dust) side and a clean (clean air) side. Screen frames are fitted with or connected to a shaking or rapping device for dislodging the dust pack from the cloth surfaces. The dislodged dust deposits in hoppers below the cloth-screen elements.

In older designs screen frames were of wood with filter fabric stretched over the frame and tacked or glued in place. In more recent designs the screen frames are wholly of metal construction, with the fabric applied over the frames as easily replaceable bags. Many refinements of design resulting from extensive operating experience have led to longer life, greater capacity per unit of space occupied, easier access for inspection, less maintenance and repair, and more effective cloth cleaning.

Cleaning the filter

Since the build-up of the dust mat on the cloth surface gradually increases collector resistance, it is necessary periodically to vibrate the cloth surface to reduce the dust pack and its resistance to air flow.

The more common collector arrangement is the intermittent type. Here the elements are cleaned by periodic operation of the shaking device while the exhauster is shut down. The frequency and duration of these cleaning periods depends on specific conditions. For average dust fineness and loading, cleaning periods of from 5 to 10 min. each may take place after each 4 to 5 hr. of operation. The cleaning period can often be decreased by installing presettling means ahead of the cloth filter. The intermittent type collector is most economical in first cost and maintenance, and is indicated where the process or schedule of operations permits short shut-downs for cloth cleaning. Generally this occurs during lunch periods or shift changes.

Continuous collectors

With today's all-out production there is increasing interest in continuous type collectors, which can operate around the clock without shut-down for rapping. The continuous cloth-screen collector consists of two or more compartments—each fitted with an individual shaking device—arranged with gates or dampers to permit alternate isolation of each compartment from the air flow during cloth cleaning

periods. This control of air flow may be accomplished, in regular cycle, through manual operation or by automatic control apparatus. In some instances where high dust concentrations are handled, an extra compartment or section is provided beyond those required by the design calculations. In this case the control is so arranged that one compartment is always shut off for cleaning.

Reverse air helps cleaning

With continuous equipment, it is frequent practice to arrange the dampers so that air is drawn in the reverse direction through the section being cleaned (see Fig. 1). This gives assurance that the pressure difference across the fabric is in the direction which helps to loosen the dust pack rather than hold it on the cloth.

Continuous collectors are more expensive from the standpoint of first cost, operation and maintenance—particularly if the cycling is highly automatic and timing equipment and motorized valves must be used.

Properly applied and maintained, cloth filters will provide effective suppression of finely divided, as well as coarse industrial dusts. However, there are several factors which must be given consideration in their application. The more limiting factors include: temperature, moisture, and the chemical qualities of both the dust and the conveying air and gas. Safe upper operating temperatures for the most commonly used filter fabrics are approximately 175 deg. F. for cotton and 225 deg. F. for wool. From rather limited experience to date, indications are that some of the newer synthetic fiber fabrics will permit a considerable increase in practical operating temperatures.

Synthetics for hard service

For example, the new synthetic fiber Orlon is being tested and observed for industrial dust filtration work for temperatures to about 350 deg. F. maximum, as well as for chemical resistance to acidic atmospheres. Other synthetic fiber fabrics also show promise for specific applications. Glass fiber fabrics have given satisfactory filtration results and good temperature and chemical resistance, but have failed mechanically. Experimental developments combining glass and other fibers, and also resins and fiber lubricants, are under way in an effort to solve this difficulty.

Still the most widely used and economical cloth is a sateen-weave cotton which collects the dust on the side where the filler threads are most exposed.

Limits on filters

Cloth filters are incompatible with condensible moisture, whether the moisture is contained in the dust, in the air, or in both. The principal cause of corrosion in cloth filters which handle materials having an acid reaction is moisture condensation. For proper operation and performance, both the dust and the conveying air must be kept dry and the collector temperature maintained well above the dewpoint at all times. The chemical properties of the air or gas, as well as of the dust being handled, must be analyzed to be sure that there is no deleterious reaction on the fabric or the collector parts.

Important factors governing cloth filter area requirements include: air volume handled; nature, characteristics and amount of material to be collected; range of dust particle sizes; and specific gravity. Filtration velocities used with intermittent collectors will vary from 2 to 4 lin. ft. per min., so that one can design for 2 to 4 cfm. of air per sq.ft. of area. With continuous type collectors this throughput per sq.ft. of filter is frequently increased.

For average conditions of industrial dust fineness, loadings up to 5 grains per cu.ft. of air indicate the use of intermittent type cloth collectors (provided plant operations permit regular, periodic shut-downs for cloth cleaning). Higher loads, particularly when constant and continuous, usually require continuous type collectors, or pre-cleaning devices, or both. Silverman[8] refers to "heavy loads such as ordinary process wastes where loadings may vary from 1 to 10 grains per cu.ft." Lapple[9] recommends that for very fine dusts or high dust loadings, the rating should not exceed 3 cfm. per sq.ft. of cloth. He states also that it may be desirable to reduce the rating to ½. Almost all authors and specialists in the field concur on a pressure drop of from 2 to 6 in. equivalent water column to strike a practical balance between collector size and low operating and maintenance costs.

It is almost impossible to give useful figures on initial cost, since the engineering requirements for proper dust control vary so widely. However, Lapple[9] gives a cost range of from $0.50 to $1.50 per sq.ft. of cloth area.

How costs vary

In the writer's experience with widely varied installations, current initial costs of intermittent type cloth collectors will average from about $1 per sq.ft. for smaller sizes, to $0.70 per sq.ft. for larger sizes. Continuous sectional type cloth collectors will average from about $1.50 per sq.ft. for smaller sizes to $1 per sq.ft. for larger sizes. These estimated costs are based on the use of standard cotton fiber fabric and do not include piping systems, exhausters, drives, motors and controls, wiring, freight, installation, etc.

High dust loadings can be reduced by presettling devices installed ahead of the cloth filters. Presettling is often accomplished by centrifugal or cyclone collectors, or by settling or baffle chambers.

When handling dusts of explosive or combustible nature, cloth filters should be fitted with relief vents. If located indoors, pressure relief vents should communicate to the outdoors through ducts with short, direct runs. Cloth filters handling explosive or combustible dust are frequently fitted with sprinkler or CO_2 systems, automatically operated from increases in either pressure or temperature.

Blow-back filters introduced

Recently reverse-air-cleaning or blow-back type filters in which cleaning is accomplished continuously have been offered for industrial application. The principle is not new since several such collectors appear in the patent art during the latter part of the last century. Current designs use pressed-wool felt tubes varying from 9 in. diam. upward. Relatively high-pressure air from an auxiliary blower is supplied to a moving blow-ring surrounding the felt tube. The inner side of the blow ring, in close con-

tact with the filter tube, has a narrow slot through which the high-pressure air is discharged through the tube in reverse direction to normal flow. The up-and-down travel of the blow-ring may be either continuous or intermittent, as actuated by differential pressure across the tube. These collectors are rated at from 5 to 30 cfm. per sq.ft. of filter surface, depending on dust characteristics and fineness. Performance tests indicate high efficiencies with heavy dust loadings. Initial cost is higher than for conventional cloth filters.

Also flat screen type

In another design the reverse-air or blow-back method of cleaning has been applied to a flat cloth screen filter by a traveling blow-chamber traversing the clean air outlets of the screens. At a given instant the traveling blow-chamber supplies air in reverse direction to the center one of three vertical rows of screens, sealing off the normal air flow through the vertical rows on either side.

The reverse-air or blow-back principle of cleaning has been demonstrated as workable in the case of the felt-tube type using the blow-ring. The reverse flow design as applied to cloth-screen filters has not yet been proven over a range of conditions and types of dust.

Most manufacturers view reverse-air flow (in one section of a multiple-section continuous collector, as in Fig. 1) as principally a means for relieving any pressure which would tend to hold the collected dust pack on the cloth surfaces during rapping or shaking in the closed-off section. As a matter of fact, reverse air flow in such collectors is frequently overdone, so that the precoat on the cloth is removed along with the main body of the dust pack and must again be built up when regular flow is resumed.

Problems in dust discharge

The discharge of dust from a collector should be given most careful consideration from the standpoint of public nuisance. Standard collectors are provided with hoppers having dust-tight discharge gates fitted with canvas tubes. By proper manipulation, dust dispersed to the atmosphere during the hopper emptying operation can be kept to the minimum. The trick is to prevent sudden dropping of dust from a considerable height. Hopper gates are often fitted with clamps for the attachment of bags to which the collected dust is directly discharged. Receptacles, trucks and containers with tight covers connected to the hopper gates by removable spouts are often used. A practice of considerable merit is to inclose entirely the space below the hoppers. This prevents air currents from dispersing the dust while it is being lowered into containers. Often an inclosure below the hoppers can be provided with an exhaust connection to maintain a slight negative pressure, and thus prevent dust dispersion.

When mechanical or continuous dust discharge is desirable, collectors are fitted with rotary air-lock valves through which dust may be discharged without shutting the collector down. Rotary valves ordinarily discharge into an inclosed conveyor. In some instances the dust is mixed with water and carried away as a sludge.

Efficiency measure: clean air

The measure of efficiency of any dust collector is not the amount of material which is collected, but rather the amount of dust present in the discharged air. Although an installation may apparently be doing an effective job by visual observation, it must be remembered that discharged air may still contain harmful dust of micron and submicron size.

The best insurance against a hard-to-trace public nuisance brought on by an inadequate dust collecting system is to consult with professionals of long experience in the field when making the original installation. Coupled with this, proper field checking and testing of the installation after it is put into operation; proper instruction of operating and maintenance personnel; and the development and enforcement of sound maintenance procedures and schedules, are all required. Definite routines should be established and followed. Inspection reports should be submitted to a designated plant executive. For the average cloth filter operating 8 or 9 hr. a day, thorough inspection should occur about twice each month. Dust collected in the hoppers must be regularly removed and not allowed to accumulate to more than half of the hopper's depth.

The following schedule is suggested as a good start toward a sound inspection routine:

Schedule for inspection

1. Inspect the collector interior to check the effectiveness of the shaking device and its frequency of operation.
2. Regularly check hoppers for dust bridging.
3. Take regular water gage readings across the collector—and compare readings made before shaking and after shaking and the resumption of normal flow.
4. Inspect the shaking mechanism and its drive, for operation, wear, adjustment and lubrication.
5. Inspect the clean side of the collector for any evidence of dust leakage through tubes, seals or bags.
6. Check the collector casing for air and weather leakage (easily done at night with one man inside the collector with a bright lamp). Particular attention should be paid to connections and flanges.
7. Regularly inspect hopper gates to insure tightness while collector is operating.
8. Frequently inspect the air control dampers of sectional continuous collectors. If automatic, inspect all timing and control apparatus.

Air-conditioning filters

The air-conditioning type of air filter must be included in any general discussion of airborne pollution—but it is seldom used to collect dust at its source and prevent its dispersion into the atmosphere. Air-conditioning type units are designed to catch those small amounts of aerosols existing in incoming air supplies. Process dust concentrations often run as high as 20 grains per cu.ft.—but if the dust is the product as in zinc oxide fume, may run as high as several hundred grains per cu.ft. Atmospheric dust concentrations, on the other hand, are generally as low as 0.005 grains per cu.ft.

The so-called viscous filters are not properly filters. They are pads of a wide variety of

materials (glass fibers, animal hair, wood shavings, fiber board, split wire, metal wool or screening, etc.) coated with dust collecting adhesives. Dry air filters may be true filters, but must be of such great porosity (to provide air-conditioning rates of flow) that they have, as Lapple puts it, "negligibly low efficiencies in separating particles below 1 micron in size, and efficiencies of around 85 percent for sizes over 10 microns. They are not, therefore, significant in the problem of pollution and public nuisance.

Some of the newer ultra-filtration media may someday prove important in public nuisance control where bacteria or very fine radioactive dusts are involved.

Little-AEC filter

Stafford and Smith[4] describe special asbestos-containing papers which will remove particles in the 0.1 to 1.0 micron size range with efficiencies of 99.9 percent or better. Such media are already in use in Atomic Energy Commission operating areas. They pass air at about 5 cfm.per sq.ft. at a pressure drop of around 1 in. of water column; and deliver nearly sterile air such as to suggest use in biological and pharmaceutical work as well as in the filtering of radioactive dusts. Though highly promising, their applications are still specialized, and relate only to low acrosol concentrations.

Goetz, Goodding and Goetz[1] describe paper-like materials in the form of gel structures of cellulose ester polymers for ultra-filtration. Such filters utilize the electrostatic charges developed by air passage through the material to increase effectiveness, even with an unfavorable relationship between pore and particle size. Capacities up to 11.5 cfm.per sq.ft. at 1 in. water column pressure differential have been reported.

Electrostatic effect

Other filters making use of electrostatic properties have also been reported. For example, one of the rubber companies has recently announced a "self-charging electrostatic air filter which takes advantage of the dielectric properties of polyethylene and other plastic materials." High efficiencies with smokes of submicron size are claimed. The filter can be cleaned and fully regenerated by immersion in water containing a detergent, and replaced immediately without deteriorating effect.

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Processes Use Many Collector Types

Settling chambers, impingement and inertial separators, packed beds and scrubbers are vital in the control of pollution.

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There are a number of forces or mechanisms which are active in the functioning of dust or mist collection equipment. These may be classified as: (1) gravitational, (2) inertial, (3) filtration or barrier, (4) electrostatic, (5) physicochemical, (6) thermal or diffusional and (7) sonic. Since many units utilize more than one of these forces, it is not convenient to classify available collection equipment according to the underlying operating principle. The tabulation on page 145 gives a classification of dust collection equipment which is based on structural and application similarities. The

Collectors classified

present paper summarizes the factors that enter into the design and operation of gravity settling chambers, inertial separators, packed beds, and scrubbers. The other classes of collectors listed in the table are covered in other sections of the symposium. For further details the reader is referred to Ref. (6) which presents a fairly comprehensive treatment of the subject and contains a bibliography of 113 references covering the more important work in the field. Details of more current work in the field will be found in Refs. (1), (2), (3), (4), (7) and (8). It should also be noted that, except for scrubbers, the equipment described in this paper is applicable only to the collection of particulate pollutants, such as dust or mists, and not for the collection of gaseous pollutants.

Gravity settling chambers

The gravity settling chamber is probably the simplest and earliest type of dust collector, consisting essentially of an open compartment into which the dust-laden stream passes at one end and leaves at the other. Gas velocity in the chamber is reduced to permit the dust particles to settle out by the action of gravity. Referring to Fig. 1, a particle will be completely removed if it can settle from point (1) to point (2), a height of H_s, in the time it takes the carrier gas to pass from one end of the chamber to the other. Expressing this mathematically, it will be found that any particle with a terminal settling velocity equal to or greater than (q/B_sL_s) should be completely settled out. Some smaller particles that are initially close to the bottom of the chamber will also settle out.

It should be noted that the velocity (q/B_sL_s) is the same as that of the fluid if it passed vertically through the area B_sL_s. Thus the performance of a gravity settling chamber depends primarily on its horizontal projected area and is practically independent of its height. The height need be made only large enough

so that the gas velocity V, in the chamber is not great enough to cause re-entrainment of separated dust. For this reason, V, should not exceed about 10 fps.

A better type

Lateral gas distribution at the gas inlet end of a gravity settling chamber is very important for the proper operation of the unit, since this determines the portion of the horizontal projected area of the chamber which is effectively used. Vertical partitions or baffle plates serve little useful purpose, but closely spaced horizontal shelves can be utilized to secure a marked improvement in collection, as in a modification known as a Howard dust chamber (Fig. 2).

Designed for the job

Gravity settling chambers are not built as standard commercial units. They are designed and built for the specific application. The simplicity of such a unit makes it suitable for almost any type of construction. Practically, however, the industrial utility of the simple settling chamber is limited to removing particles larger than 325 mesh (43 microns diam.) since the required chamber size for removing smaller particles is generally excessive. The most frequent application is on natural draft

General Types and Characteristics of Dust and Mist Collection Equipment

This table gives relative cost and performance data for the main types of units used for removing particulate pollutants. The values given must not be taken too literally, but should serve as a guide in selecting units for given applications. In a broad summary of this type it is not possible to cover every conceivable case and in individual cases wide variations from the values given here may sometimes be encountered.

Equipment Type	Approximate Equipment Characteristics: Purchase Cost, $/Cfm.*	Minimum Collectible Particle Diam., Microns	Pressure Drop Through Equipment, In. Water	Power Consumption**, Kw./1,000 Cfm.	Applications, Remarks
A. Gravity settling chamber					
1. Simple		40	0.1–0.5	0.1	Simple, large, low pressure drop; precleaners natural draft exhausts.
2. Howard		10	0.1–0.5	0.1	Difficult to clean, warpage problem.
B. Inertial separators					
1. Impingement separators	0.10–0.20				Adaptable to existing flues.
a. Calder-Fox		2	1–5	0.2–1.0	Sulphuric acid mist removal.
b. Miscellaneous		10	0.2–2	0.1–0.5	
2. Cyclone separators			1–5	0.2–1.0	Simple, inexpensive, most widely used.
a. Single	0.04–0.06	5			
b. Multiple	0.15–0.50	2			
3. Mechanical centrifugal separators	0.10–0.30	5		0.5–2.0	Compact; ventilation booths.
4. Miscellaneous inertial separators			1–2	0.2–0.5	May be adaptable to existing flues.
C. Packed beds					
1. Fine	2.00–5.00†	<1	1–10	0.2–2.0	Removal of radioactive aerosols; sulphuric acid mist removal.
a. Granular (<4 mesh)					
b. Fibrous (<0.005 in.)					
2. Coarse		5	0.2–2	0.1–0.5	Entrainment elimination.
a. Granular (>4 mesh)					
b. Fibrous (>0.005 in.)					
D. Scrubbers		0.5	0.1–50	0.1–10.0	Dust is wetted; sludge disposal and corrosion problems.
1. Chamber type	0.15–1.50				
2. Cyclone type	0.30–1.00				
3. Inertial type	0.30–1.00				
4. Mechanical type	1.00				
5. Packed type					
6. Film type					
7. Miscellaneous					
E. Cloth collectors		<0.1	2–6	0.5–1.5	High collection efficiency; temperature and moisture limitations.
1. Baghouse	0.50–2.50				Simple, large.
2. Unit filter	0.15–1.50				For small capacities (<1,000 cfm.).
3. Mechanical filter	0.10–0.70				For high capacities.
4. Automatic filter	0.50–2.00				For high dust concentration (>20 grains/cu. ft).
F. Electrical precipitators		<0.1			
1. Single-stage	0.30–1.50		0.1–0.5	0.2–0.6	For process gases; heavy duty, expensive on first cost and operation.
a. Plate type					
b. Pipe type					
2. Two-stage	0.10–0.30		0.1–0.3	0.1	Small, compact; air conditioning applications.
3. Alternating current					Not used industrially; sampling applications.
G. Air filters			0.1–0.5	0.1	High capacity, low resistance; for low dust concentrations, air conditioning applications.
1. Viscous	0.005–0.030	5			
2. Dry	0.005–0.030	2			
3. Automatic	0.05 –0.10				
4. Miscellaneous					
a. Wetted cells					
b. Electrostatic (see F 2 above)					
c. Pipeline					
d. Activated carbon					For odor removal.
H. Miscellaneous					
1. Sonic	1.00	<0.5	0.2–6	1–5	Only recently of industrial importance.
2. Thermal					Not developed for industrial application; used for sampling.

* For mild steel construction based on prices for period 1945–1946. ** Covers total power, including electrical energy, water pumping power, pressure drop through apparatus, and power for necessary auxiliary equipment. † For deep-bed types only.

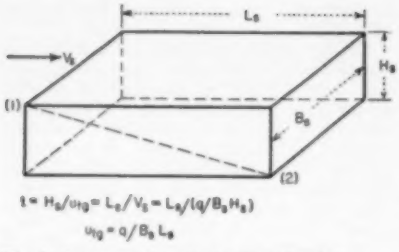

Fig. 1—Operation of gravity settling chambers.

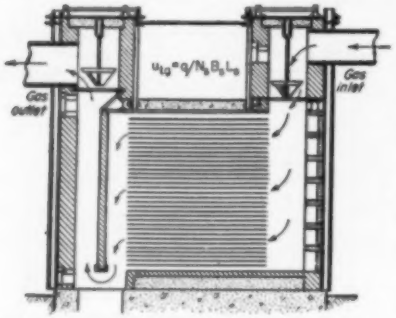

Fig. 2—Howard type settling chamber.

Little pressure loss

exhausts from kilns and furnaces, owing to its low pressure drop and structural simplicity. The pressure drop consists entirely of entrance and exit losses. A Howard type of unit can be used to remove particles as small as 10 microns diam. Its chief disadvantages are the difficulty of cleaning owing to the close shelf spacing, and warpage at elevated temperatures. It should have very definite application for liquid entrainment separation.

Impingement separators

An impingement separator is a device in which the dust- or mist-laden gas stream is caused to pass around or through fixed elements interposed in the gas stream. The greater inertia of the suspended particles will result in a tendency for the particles to deposit on this collecting element, rather than to follow the gas around the element. Thus a certain fraction of the particles in the gas volume "swept" by the collecting body will impinge on the body. The efficiency of collection is a function of the dimensionless group $u_{tg}V_w/g_cD_b$. There is at present considerable disagreement in the literature regarding the quantitative nature of the relationship. As a generality, it may be stated that if the value of the group is greater than 1, the efficiency of impaction will be large (over 50 percent); whereas, if its value is less than 0.1, the efficiency of impaction will be negligible. Thus, high velocity and small collection elements are conducive to more effective separation. High over-all collection efficiencies can be obtained by using large numbers of collecting elements in series.

As a whole, impingement separators are designed for pressure drops in the range of 0.1 to 1.5 in. water, depending on the type and the application. They are limited to removing dusts that are predominantly larger than 10 to 20 microns diam. The chief advantage of such units lies in their ready adaptability to existing flues and ducts.

Calder-Fox scrubber

The Calder-Fox "scrubber" is a British development in this class, intended primarily for the collection of sulphuric acid mist. It consists essentially of one or more pairs of closely spaced plates in series, where each pair of plates contains orifices staggered with respect

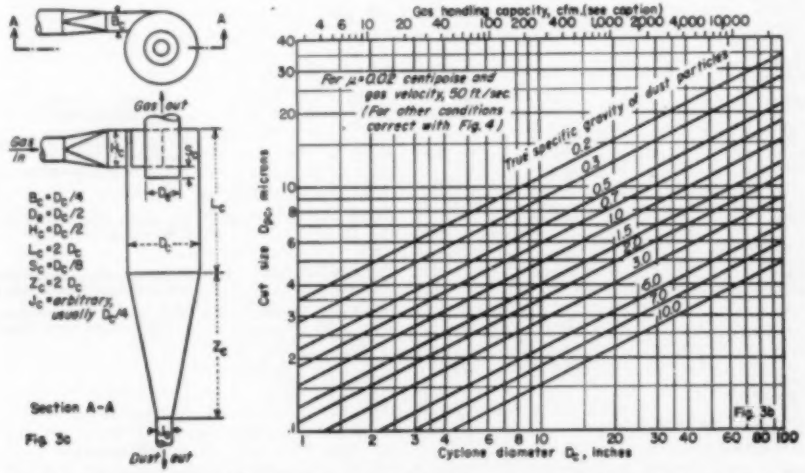

Fig. 3—(a) Proportions for typical cyclone design. (b) Cut size in microns for cyclones of Fig. 3a. For other gas viscosities and velocities multiply cut size by correction factors from Fig. 4 (but cut size must be determined from diameter scale at bottom of Fig. 3b, and not from capacity scale at top). Capacity scale gives air handling capacity at inlet temperature and pressure and 50 fps. for cyclones of diameter vertically below.

to each other. This unit is reported to be effective in collecting mist particles as small as 2 microns diam. The cascade impactor[8] is a recent development in the field of particle size analysis which is essentially an impingement separator.

Cyclone separator

One of the least expensive and most widely used types of dust collectors is the cyclone separator. It consists essentially of a conical or cylindrical chamber (Fig. 3), with the gas entering tangentially at one or more points. Gas leaves axially at one end, the dust discharging into a receiver at the other end. The action is similar to that of a gravity settling chamber where gravitational acceleration of the dust particles is replaced by centrifugal acceleration, which causes the dust particles to move outwards toward the separator wall.

Over five microns

Cyclones are generally applicable for removing solid or liquid pollutants from gases when the particles are larger than 5 microns diam. Unless very small diameter cyclones are used the efficiency of collection will be low if much of the suspended matter in the gas is finer than 5 microns. Cyclones may be used for collecting particles larger than 200 microns but in that case gravity settling chambers will usually be more satisfactory, having a lower pressure drop and being less subject to abrasion wear. In certain cases, collection efficiencies of over 98 percent have been realized with cyclone collectors on dusts having an ultimate size of 0.1 to 2.0 microns, but here the suspended particles were highly flocculated. Extensive flocculation may be expected when dealing with dust concentrations greater than 100 grains per cu.ft. although it may be present at much lower concentrations.

NOMENCLATURE

- B_c = Width of rectangular cyclone inlet, ft.
- B_s = Width of gravity settling chamber, ft.
- D_b = Representative dimension or diameter of body or packing impinged or deposited on, ft.
- D_p = Diameter of dust or mist particle, ft.
- D_{pc} = Cut size, i.e., that diameter of particle of which 50 percent of those present will be collected, ft.
- D_v = Diffusion coefficient or diffusivity, sq. ft./sec.
- g_c = Conversion factor, 32.17 (lb. mass/lb. force) (ft./sec.^{2}).
- g_L = Local acceleration due to gravity, ft./sec.^{2}
- h_{vi} = Cyclone inlet velocity head, in. water.
- H_s = Height of gravity settling chamber, ft.
- k_m = Stokes-Cunningham correction factor, dimensionless
- L_s = Length of gravity settling chamber in direction of gas flow, ft.
- N = Number of gas molecules in a mole, 2.76×10^{26} molecules/lb. mole.
- N_e = "Effective" number of turns made by gas stream in a cyclone separator, dimensionless.
- N_s = Number of horizontal shelves in gravity settling chamber, dimensionless.
- q = Gas flow rate, cu. ft./sec.
- R = Gas constant, 1,546 (ft.-lb. force) /(lb. mole) (deg. F.).
- t = Time, sec.
- T = Absolute gas temperature, deg. R. or deg. F. abs.
- u_{tt} = Terminal settling velocity of particle under the action of gravity, ft./sec.
- V_c = Average cyclone inlet velocity, ft./sec.
- V_s = Average gas velocity in gravity settling chamber, ft./sec.
- V_0 = Average superficial velocity of dust-laden gas, ft./sec.
- ρ = Gas density, lb. mass/cu. ft.
- ρ_p = True (*not* bulk) density of dust or mist particles, lb. mass/cu. ft.
- μ = Gas viscosity, (lb. mass)/(ft.) (sec.).

Friction loss

The friction loss through a cyclone may be conveniently expressed in the terms of the velocity head based on the immediate cyclone inlet area. This inlet velocity head, expressed in inches of water, may be calculated as follows:

$$h_{vi} = 0.00300\ \rho\ V_c^2$$

The friction loss through cyclones encountered in practice may range from 1 to 20 inlet velocity heads, depending on the geometric proportions. For a cyclone of the proportions shown in Fig. 3 (Ref. 6), the friction loss is approximately 8 inlet velocity heads.

To compute performance

The performance of a cyclone can be specified in terms of a cut size D_{pc}, which is the size of dust or mist particle which the cyclone will collect to the extent of 50 percent. The cut size of a cyclone depends on the dust properties, the gas properties, the cyclone size, and the operating conditions and may be calculated from

$$D_{pc} = \sqrt{\frac{9\ \mu\ B_c}{2\ \pi\ N_e\ V_c\ (\rho_p - \rho)}}$$

The term N_e, defined as the effective number

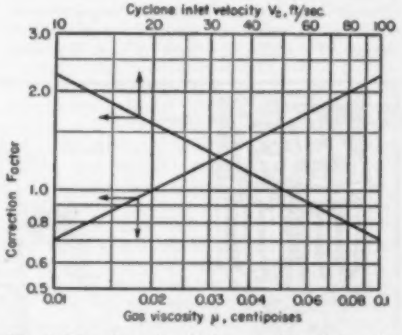

Fig. 4—Viscosity and velocity correction factors for cut size of cyclones in Fig. 3.

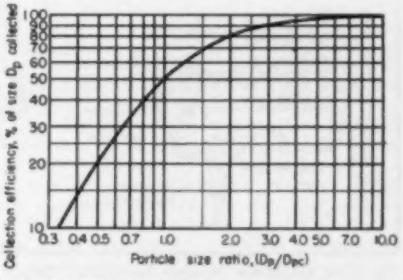

Fig. 5—Relationship between collection efficiency and particle size for cyclones of Fig. 3.

of turns made by the gas stream in the cyclone, is actually an empirical quantity which must be determined experimentally. It should, however, be a constant for any size of cyclone of the same geometric proportions. For a cyclone of the proportions shown in Fig. 3a, N_e has been found to be about 5. Figs. 3b and 4 present charts which may be used to estimate the cut size of a cyclone of the proportions shown in Fig. 3a, for various cyclone diameters, particle densities, and operating conditions.

Particles larger than the cut size D_{p_c} will be collected to an extent greater than 50 percent, while smaller particles will be collected to a lesser extent. This may be represented quantitatively by a curve as shown in Fig. 5, which is essentially a generalized form of the "fractional" efficiency plot frequently found in commercial literature. The specific values given in Fig. 5 apply for any cyclone of the proportions shown in Fig. 3.

Many cyclone types

Cyclones are generally designed to meet specified pressure drop limitations. These set the normal operating range corresponding to an inlet velocity of 20 to 70 fps., usually about 50 fps. A large variety of makes and configurations are commercially available. Typical units are shown in Fig. 6. While the simplest arrangement for a specific application is to use a single cyclone suitably sized for the capacity involved, it is often desirable, when dealing with large air handling capacities, to use an arrangement of multiple small cyclones in parallel in order to attain higher collection efficiencies and reduce headroom requirements. Cyclones in series are generally not justified except (1) where the dust is very fine and has a relatively uniform particle size distribution, and (2) where the dust is present in a highly flocculated state. Where flocculation is pronounced, estimates of cyclone collection efficiency based on the particle size analysis of the dust will be highly conservative. Also, while collection efficiency is normally increased by increasing the gas throughput, in such cases the reverse may be the case due to the deflocculating effect of the higher velocities.

Effect of diameter

In the removal of dusts, the collection efficiency can be changed to only a minor extent by variations in operating conditions. The primary design factor that can be utilized to control collection efficiency is the cyclone diameter. A smaller diameter unit operating at a fixed pressure drop has a higher collection efficiency but requires a multiple of units in parallel for a specified gas handling capacity. A cyclone will operate equally well on the suction or pressure side of a fan if the dust receiver is airtight. Probably the greatest single cause for poor cyclone performance, however, is the leakage of air into the dust outlet of the cyclone. A slight air leak at this point can result in a tremendous drop in collection efficiency, particularly with fine dusts. For continuous withdrawal of collected dust, a rotary star valve, a double-lock valve, or a screw conveyor may be used. Devices, such as cone and disk baffles, guide vanes, straightening vanes, etc., placed inside of a cyclone have in general been found to be of dubious value or actually detrimental.

Collects liquids also

Cyclones may be used effectively for the removal of liquid droplets from gases, as in the discharge from absorption columns and evaporators. For such applications, however, special

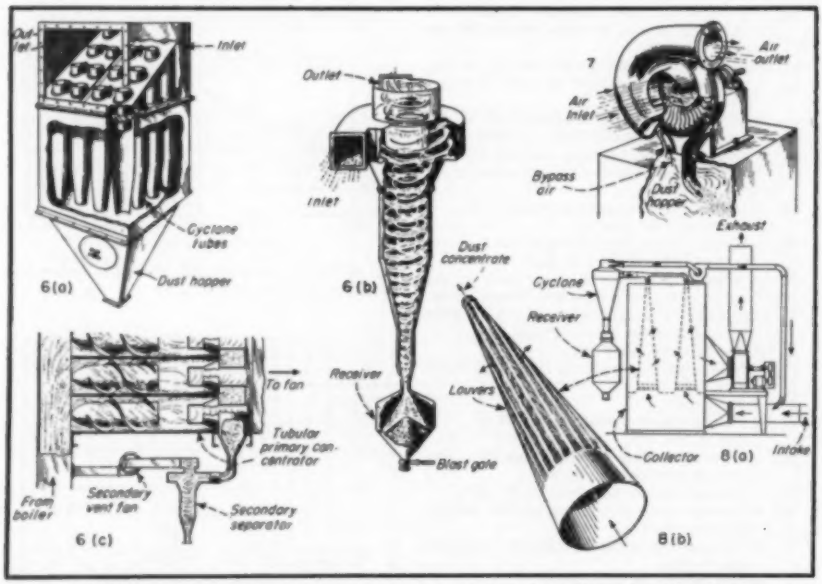

Fig. 6—(a) Multiclone (Western Precipitation Corp.); (b) Sirocco Type D cyclone (American Blower Corp.); (c) Sirocco fly ash collector (American Blower Corp.).

Fig. 7—Type D Rotoclone (American Air Filter Co.).

Fig. 8—(a) Aerodyne collector; (b) detail of Aerodyne tube (Aerodyne Development Corp.).

provisions must be made to prevent the collected liquid from being carried out again as a film by the exit gases. These are discussed in more detail in Ref. (6), p. 1028.

Centrifugal collectors

In mechanical centrifugal separators the centrifugal field is developed by a driven rotor rather than by the curvilinear flow of the gas. They are essentially fans into which are incorporated provisions for removing the dust or mist which is thrown outward by the action of the centrifugal field. A typical unit is shown in Fig. 7. Although no comparative data are available, the collection efficiency of units of this type is probably comparable to that of a single-unit, high-pressure-drop cyclone installation. The chief advantage of these units lies in their compactness which may be an important consideration for large installations or plants requiring a large number of individual collectors. Caution must be exercised when attempting to apply this type of unit to a dust that shows a marked tendency to build up on solid surfaces, because of possible high maintenance costs due to rotor unbalancing.

There are several commercially available collectors of the inertial type that do not fall specifically into any of the previous categories. These range in nature from a simple high-velocity gas reversal chamber to a rotary unit containing closely spaced parallel sinusoidal plates. Most steam or compressed air entrainment separators are of the inertial type and are intended for the removal of droplets larger than 20 microns diam.

Aerodyne collector

A recent development in this class is the Aerodyne collector (Fig. 8) in which the dust-laden gases enter at high velocity—100 fps.—at the base of a long cone. The sides of the cone are slotted, with the openings pointed in the reverse direction. Most of the gas leaves through these slots while the dust, by virtue of its greater inertia, tends to remain in the cone. Finally it is concentrated in a small fraction of the original gas which carries it out of the apex of the cone to a small cyclone collector. The gas from the cyclone collector is then recycled to the inlet of the cone. The manufacturer's performance curves would indicate that this unit has a collection efficiency comparable to that of a medium-sized single cyclone collector. The chief indicated advantages of the unit are that performance is presumably independent of size, that it is reasonably compact, and that it may lend itself more readily to installation in some instances.

Packed bed collectors

Particulate pollutants can be removed from gas streams by passing the gases through a bed or layer of packing which may consist of granular materials, such as sand, coke, or Raschig rings, or of fibrous materials, such as glass or steel wool. The depth of the bed may vary from a fraction of an inch to several feet, depending on the application and the type of packing. The deposition of the particles on the packing may result from one or more of the following mechanisms, depending on the nature and size of the dust or mist particles, the nature and size of the packing material, and the operating conditions: (1) interception, (2) impingement, (3) Brownian diffusion, (4) gravity settling, and (5) electrostatic attraction. With the coarser packing materials, impingement is usually controlling; while interception, diffusion and gravity settling are predominant in beds of finer packing materials, with electrostatic effects as a possibility.

Collection effectiveness

The general principles of collection by gravity settling and impingement have been previously discussed. The effectiveness of collection by interception is a function of the ratio D_e/D_c while that of Brownian diffusion depends on the group D_e/V_sD_c. The larger the value of the group or ratio in each case, the greater the collection efficiency. The diffusion coefficient of an aerosol D_e may be calculated from

$$D_e = \frac{g_c R T k_m}{3 \pi \mu N D_p}$$

The value of k_m will differ significantly from unity for particles smaller than 1 micron. The value of D_e for a 1 micron particle is on the order of 3×10^{-10} sq.ft. per sec. The principles involved in possible electrostatic phenomena have not yet been adequately developed. For further details see Perry[5], Johnstone and Roberts[4] and Rodebush.[2]

Range of use

Beds of coarse packing are usually used at relatively high capacity—1 to 15 fps. superficial gas velocity—for removing coarse dust or mist particles (larger than 5 microns diam.). Beds of fine packing are used at relatively low capacity—1 to 50 fpm. superficial gas velocity—for removing very small particles (smaller than 5 microns). The question of bed life is an important one and is determined by dust concentration and particle size. For this reason, packed beds are limited to the handling of relatively low dust concentration, unless a moving bed is involved. This can be done, as in the Lynch granular filter[6] by periodically or continuously withdrawing the packing for cleaning, as by screening or by using a fluidized bed. In the case of mist and sprays, packed beds are generally self-draining although life may still be a consideration owing to the additional presence of small amounts of dust. Fibrous beds have two basic advantages over granular beds: (1) They are considerably lighter in weight and hence require less structural support, and (2) they have a higher dust capacity.

As a whole, packed beds are not produced as commercial units but are engineered specifically for each application. Chambers packed with sized coke have been successfully used for the collection of sulphuric acid mist. Sand filters and glass wool filters have been successfully applied for removing small amounts of radioactive contaminants from very large volumes of gaseous wastes with very high collection efficiencies.

Scrubbers for dusts or mists

In the category of scrubbers are included all devices which utilize a liquid, usually water, to assist in the removal of a dust, mist, or vapor from a gas stream. There is a very large variety of equipment available in this class. Some units are simply modifications of one of the dry types of separators to permit the addition of liquid, while others are specifically designed for wet operation and cannot be used without liquid addition. The following functions or

mechanisms may be responsible, individually or severally, for the manner in which collection is achieved in a scrubber: (1) impingement and interception, (2) diffusion, (3) humidification, (4) condensation, (5) wetting, (6) gas partition, (7) dust disposal and (8) electrostatic precipitation. The nature of each of these is discussed in more detail in Ref. (6).

Scrubber types

Because of the wide variety of scrubbers, and the many possible functional mechanisms, it is difficult to develop a comprehensive classification of types. In the foregoing table scrubbers have been classified into several categories according to similar structural features. Actually, performance capabilities within each category may be widely different. Scrubbers in which the gas simply enters and leaves a chamber where one or more spray nozzles are mounted have been termed "chamber scrubbers". The chamber may be large to slow down the gases, or it may be in the form of an ejector to speed them up. The venturi scrubber (Fig. 9a), which has recently received wide attention because of its high potential collection efficiency, would fall into this group. Scrubbers which utilize centrifugal action due to tangential or vaned gas inlets, as in Fig. 9b, have been termed "cyclone scrubbers". Those in which gas velocity is used to secure liquid contacting and which do not conveniently fall into one of the other classes have been termed "inertial scrubbers" as in Fig. 9c. Scrubbers termed "mechanical types" are those in which an externally driven rotor is employed for contacting purposes, as in Fig. 9d.

Packed scrubbers

A coarse packed bed, either granular or fibrous (Fig. 9e), over or through which a liquid is circulated in addition to the gas, is termed a "packed scrubber". In "film scrubbers" a liquid is circulated over the scrubber elements. The liquid is not contacted with the gas other than at the surface of the element, but serves to keep the collecting surface free of particles and to prevent re-entrainment of deposited particles. All units which do not fall conveniently into one of the above categories have been listed simply as miscellaneous.

Design varies with use

The design and performance of scrubbing equipment are quite different, depending on whether a gaseous or particulate (dust or mist) pollutant is to be removed. The same scrubber will usually not be adequate for both functions. It is usually advantageous to have the air flow countercurrently to the absorbing liquid when dealing with gaseous pollutants. The types of scrubbers applicable to the problem are, therefore, limited. For very soluble gases at low concentration, such as hydrogen chloride vapors, concurrent contacting would probably be adequate. The principles of operation and design of scrubbers for removing gaseous pollutants are covered in detail in Section (10) of Ref. (6). The equilibrium relationships between the gaseous pollutant and the scrubbing liquid, the temperature and pressure, and the retention or contact time may all play an important role. Towers filled with ceramic or other packing are frequently used although they may be subject to plugging if much particulate matter is also present. Grid-packed towers have successfully overcome this difficulty.

Criteria for use

Scrubbers are indicated as a potential means for the collection of particulate contaminants if: (1) It is permissible or desirable to add liquid to the air stream from the standpoint of the process, health, and safety; (2) the particulate matter is very fine (predominately under 10 microns diam.); (3) a very high collection efficiency is required; (4) the gas must be cooled; and (5) vapors or gaseous matter must also be removed from the air stream. A scrubber will usually not be applicable if an inertial separator, such as a cyclone, will perform satisfactorily. This is because scrubbers will usually run higher in cost. Scrub-

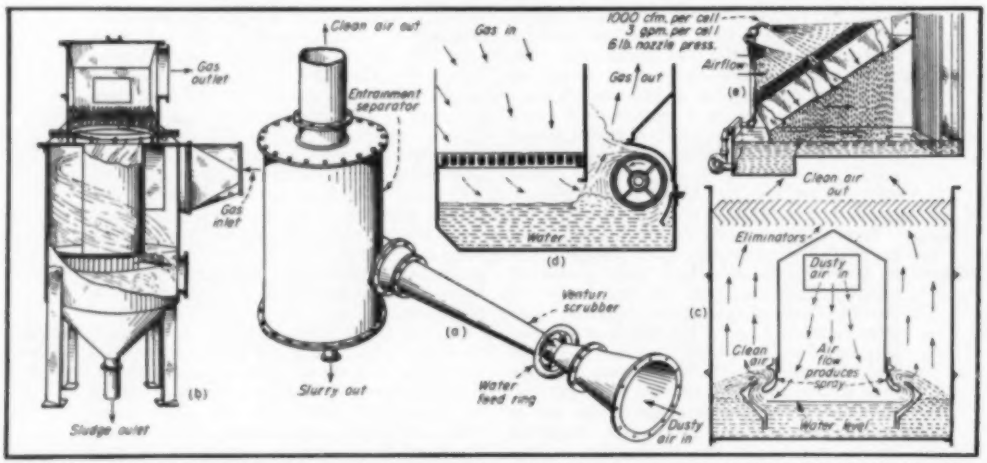

Fig. 9—Group of typical scrubbers: (a) Pease-Anthony venturi scrubber (Chemical Construction Corp.); (b) Hydro-clone (Whiting Corp.); (c) Type N Rotoclone (American Air Filter Co.); (d) Centri-merge (Schmieg Industries); (e) Capillary Conditioner (Air & Refrigeration Corp.); for illustrations of other types see Ref. (6).

bers are normally competitive with cloth collectors (bag filters), although they may be used to handle conditions where bag filters are not applicable because of temperature, moisture conditions, explosion hazards, etc. Problems that must receive special consideration in applying scrubbers include: (1) corrosion due to the addition of the scrubbing liquid; (2) liquid entrainment in the air stream leaving the scrubber; and (3) disposal or recovery of the sludge or slurry from the scrubber.

Many commercial types

In removing particulate pollutants, countercurrent operation usually has no particular advantages (or disadvantages) over concurrent operation, except in special cases where other functions, such as concentration of liquid solutions, are to be performed simultaneously. Because so many commercial types are available and because comparative operating and economic data are scarce, it is not possible to give any specific broad recommendations. The author is aware of research, currently being prepared for publication, which indicates that the controlling factor in the collection efficiency of scrubbers on particulate contaminants is the over-all pressure drop; and furthermore that the type and geometry of the scrubber is of only secondary importance. In many cases a relatively small increase in pressure drop may result in a large increase in collection efficiency. Scrubbers, properly designed, are capable of giving a collection efficiency in excess of 99 percent. The pressure drop or power consumption required, however, will depend on the particle size of the particular dust involved.

Scrubber performance

Normally the water circulation rate in dust scrubbers, per 1,000 cu.ft. of air handled per min., is in the range of 2 to 10 gpm., although certain types may run as high as 200 gpm. The water consumption or makeup rate will depend on the evaporation losses, on the concentration of dust present in each specific case, and on the amount of recirculation that can be employed. With certain types of units, practical operating considerations may preclude recirculation.

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Precipitators Stop Dust and Fumes

Versatility in recovery of fine aerosols of both liquid and solid contaminants means many jobs for the precipitator.

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In a recent article, A. J. Haagen-Smit[1] gives some interesting data regarding air pollution in the Los Angeles area, which he estimates to be roughly 625 square miles. On days when the atmospheric inversion layer extends to, say, 1,000 ft. elevation (which is a common occurrence), there is a stagnant reservoir of air over the city which weighs about 650 million tons. This large but limited reservoir soon becomes polluted by waste matter from the city. If this waste matter consisted entirely of acrolein, for example, he estimates that 80 tons of it would be noticeable to the inhabitants, 3,500 tons would cause them to shed tears involuntarily, and about 180,000 tons of it would be lethal in 10 min.

Reactions in the air

Extensive studies have indicated that, in the Los Angeles area, organic material in the air—such as that released by incomplete combustion of oil, gasoline, trash, etc.—reacts with ozone or perhaps other contaminants like nitrogen oxides. This occurs under the influence of sunlight, forming an aerosol which is responsible for a large fraction of the smog actually observed over the city on days when there is an atmospheric inversion layer. The figures cited in the paragraph above indicate that atmospheric pollutants in industrial areas must be escaping in very large quantities in order to have become such a nuisance, not to say health menace.

Industry's dusts and fumes

If such processes contribute a major share of urban smog, it is seen that only a portion of the pollutants which ultimately annoy the people and injure plant life originally entered the atmosphere in the same chemical state as they have when they do the damage. Thus the collection (by precipitators, for example) of all aerosols entering the air from factory chimneys, etc., may still not prevent aerosols from forming in the air and causing smog. Nevertheless, some of the dust and fume which is visible in the air in industrial neighborhoods quite commonly escapes as dust or fume from the mills and factories. Among these, for example, are cement plants, as well as steam power plants, open hearth furnaces, and the like. In collecting pollutants of this type to prevent smog, one of the

most effective devices is the Cottrell precipitator. A large number of the industrial precipitators were installed because the material collected had value sufficient to make its collection profitable. This is particularly true in the metallurgical industry. There are also many precipitators in operation which collect 100 tons or more of flyash or cement dust per day, and have been doing so for many years. Electrical precipitators are also widely used for air conditioning purposes, for example in removing tobacco smoke from the air in auditoriums or other public places.

Cottrell principles

A Cottrell precipitator consists essentially of a number of high voltage electrodes within a chamber through which the fume- or dust-laden gas is passed. In industrial precipitators the suspended particles acquire a negative charge as they pass near a system of wires or small rods which is maintained at a negative potential of the order of 25 to 100 kilovolts. (In air conditioning precipitators the polarity is usually positive, in order to minimize ozone generation.) This system of wires or rods is called the "discharge electrode" because its high voltage creates a corona or brush discharge, which charges the particles passing through it. In the usual single-stage precipitator, the charged dust is repelled by the discharge electrode and attracted by the collecting electrode upon which it is precipitated by the high voltage electrostatic field. The collecting electrode is ordinarily grounded, and has a large surface area upon which the dust can collect.

Two-stage precipitators

In the less common two-stage type of precipitator (which, however, is usual in air conditioning) the charged dust passes on into a separate collecting section after it leaves the charging section. This collecting section contains a system of electrodes, some of which are grounded, the rest being maintained at high voltage but so shaped that no corona discharge occurs. This permits a higher voltage gradient to be applied than that attainable in the charging section, so that increased electrostatic forces are available to make the precipitation process more rapid and efficient. In industrial precipitators, the collecting electrodes consist of tubes, plates, wire mesh, rod curtains, graded resistance concrete plates, plates with baffles or pockets, or other forms. The designer chooses the best type to meet the particular application at hand.

Where Cottrells are used

During the 43 years since Cottrell precipitators were first built for collecting industrial aerosols, they have been very widely used for collecting dust in cement plants, flyash in coal-fired power houses, salt cake fume from black ash furnaces in pulp mills, metallurgical fume from smelters, powdered catalyst in oil refineries, acid mist in chemical plants, and various other aerosols in many industries. These widely varying applications demonstrate the versatility of the device, which is adaptable to high or low temperatures, high or low pressures, fine fume or coarse dust, corrosive or neutral gases, and to solid or liquid aerosols. Cottrell precipitators require practically no pressure difference to force the gas through, and their efficiency is largely a matter of size and cost. In general, the efficiency

Construction view of three combined Multiclone precipitator units at the Sewaren Generating Station of Public Service Electric and Gas Co., in New Jersey.

can be increased from 90 to 99 percent by doubling the size of the precipitator. The cost may therefore be as low as $0.25 per cfm., or as high as $20, depending on efficiency, etc.

Various modifications

In order to adapt the precipitator to various applications, it is built in a variety of forms. It may be built so that the precipitated material is washed off of the collecting electrodes by a liquid, as fast as it is precipitated. In this case, there may be a nest of vertical pipes, each several inches in diameter, with a water film flowing down the inner walls of the pipes. Here the discharge electrode will consist of a charged wire stretched along the axis of each pipe. Most precipitators are designed for dry operation, however, usually built with the discharge wires or rods arranged parallel to each other and in vertical planes, midway between parallel collecting electrodes. These collecting electrodes are not usually flat plates, but consist of such forms as rod curtains (to dislodge dust which tends to cling), channels or pockets to shield the dust from the gas stream and prevent its being re-entrained after having been once precipitated, or hollow boxes with slots (sometimes called "tulips"). The gas flow may be either horizontal or vertical.

Cleaning needed

When the precipitated material is dry, it is dislodged from the collecting electrodes by devices which rap them at suitable time intervals, causing the dust to fall into the hoppers. To minimize re-entrainment of the dust during the rapping process, it is often the practice to close off the unit being rapped by dampers. This can be done in large installations where two or more other units are available to handle the gas while the first unit is rapping. In some applications, it is practical to make the rapping intervals as short as a minute or less, and to rap gently. This makes the process of dislodging the dust essentially continuous.

Because of the versatility of precipitators, it is practical to combine them with other types of dust collecting equipment, for example, cyclonic collectors. In several modern installations at coal-burning central stations, the flue gases first pass through a collector of the cyclonic type which removes nearly all of the coarse flyash particles (above 10 microns) and some of the fine ones. Then the gases enter the precipitator which collects nearly all of the remaining flyash. Such combinations of collectors are sometimes more economical and practical than either type would be alone.

Operating limitations

For ordinary dry operation, the maximum temperature of the gas entering the precipitator should not exceed about 700 deg. F. Otherwise, the steel frames and plates may warp, spoiling the accurate alignment and spacing of the electrodes. If the gases have a high temperature such as 2,000 deg., they may be cooled to 700 deg. by means of water sprays, or by dilution with cold air. Gas at low temperature, such as −100 deg. F., is readily handled, provided it is sufficiently dry not to form frost on the electrodes and walls.

At intermediate temperatures, e.g., around 200 to 275 deg. F., difficulty may be encountered in precipitating some dusts if the gas is very dry because this is the region in which most dusts attain their maximum electrical resistivity. If this exceeds 10^{11} ohm-cm., the layer of dust clinging to the collecting electrodes behaves like an electrical insulator and prevents the precipitator from operating efficiently[4,5]. This difficulty can be avoided in most cases by humidification, by raising or lowering the temperature, or by "conditioning" the dust with suitable chemicals (depending upon the composition of the dust), such as ammonia. If the material to be collected has very low electrical resistivity (e.g., carbon black which has a resistivity around 10^{-5} ohm-cm.) then it will not cling to the collecting electrode and re-entrainment becomes a serious problem. In collecting carbon black, it is usual to pass the gas first through a precipitator and then into a cyclone. The carbon black escaping from the precipitator is highly agglomerated and hence can be caught by a cyclonic collector. If the material being collected is very corrosive, as for example sulphuric acid mist, the precipitator must be made of lead or other suitable material for the application at hand.

Gas distribution

The problem of distributing the incoming gas properly so that it does not blast down one side of the precipitator, but flows in the desired direction with nearly uniform velocity at all points, is an important one. Wind tunnel studies have proved very helpful in solving this problem. The gas velocity at the electrodes in a precipitator is ordinarily in the range of 2 to 20 fps., depending upon the dust, the conditions of collection, and the type of electrodes.

The principal devices competing with the precipitator for use as collectors of industrial aerosols[4] are (1) centrifugal collectors, (2) washers and scrubbers, (3) baghouses, and (4) ultrasonic agglomerators. In many modern installations, some of these devices are combined. For example, the use of cyclones and precipitators combined in a single unit is sometimes more economical than the use of precipitators alone. Other usual combinations are centrifugal scrubbers, ultrasonic agglomerators followed by cyclones, as well as cyclones followed by scrubbers.

Comparing collectors

To compare these alternative devices with each other and with a precipitator in general terms is likely to be misleading, for the comparison depends upon such factors as the particle size distribution of the dust, the pressure drop available, the space available for the collecting equipment, the gas flow rate and whether it is steady or fluctuating, and many other factors which vary from plant to plant. However, in order to give some idea of the comparative advantages and disadvantages of the various types of collectors, the following general statements may be set forth with the understanding that there will be many instances where such general statements are untrue.

Vs. the centrifugal type

In general, a centrifugal collector is the cheapest type to build and install. The commonest type is the cyclone, which may be built in large individual units for collecting coarse dust, or in multiple units made up of many small cyclones for reasonable efficiency in collecting fine dust in which a fair percentage of the weight consists of particles below 10 microns diam. Such cyclones require less room for handling a given amount of gas per minute than any other common type of collector, they last a long time with small upkeep, they will stand high temperatures, and may be made of corrosion resistant material if necessary. However, their efficiency is low compared to that of a precipitator, and a pressure drop of at least 1½ in. of water must be maintained to make them operate properly. This requires a suitable fan and considerable power to drive it. A cyclone will not operate satisfactorily when the gas flow rate is reduced considerably below its rated capacity.

In general, a baghouse is practically 100 percent efficient if properly maintained. Its original cost is sometimes slightly less than that of the equivalent precipitator. However, a baghouse will not withstand temperatures above about 300 deg. F. in general. It will not collect liquids or corrosive materials, it ordinarily builds up a back pressure comparable to that for a cyclone, it requires more space than most other collectors of equal capacity, and the upkeep is high.

Vs. the scrubber

In general, a scrubber is well adapted for applications where the temperatures are high. The original cost may be lower than for other collectors of equal capacity, it may be built of ceramics to make it corrosion resistant, and its size is reasonably small for its capacity. However, high efficiency in collecting fine dust or fume may be attained only by expending considerable power as in packed towers, the venturi scrubber or the Theisen scrubber. The upkeep expense for such scrubbers is high, much water is required, and the collected material must be separated from this water, which often is a difficult and annoying problem.

In general, the ultrasonic agglomerator is easily adapted to treating corrosive material like

acid mist, it will withstand high temperatures, and in some cases will yield efficiencies of 90 percent, a figure that is better than most cyclones or scrubbers but not as good as those for a baghouse or most precipitators. Moreover, the original cost may be somewhat lower than that of an equivalent precipitator. However, the ultrasonic agglomerator must ordinarily be followed by a cyclone (which will not function properly if the gas flow rate varies widely), so that the power requirements are equal to those for a cyclone (which is considerable) and a powerful cycloidal blower is required in addition, to supply compressed air for the siren.

To conclude, then, it is evident that electrostatic methods are prominent and important among the means for the collection of air-borne pollutants.

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Sonic Agglomeration—A New Solution

Sound energy can be used to agglomerate aerosol particles for collection by other devices. Uses are developing.

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In a sonic agglomerator aerosols—dusts, smokes, fumes, fogs, or mists—are subjected to high-intensity sound. This sound causes the gas-borne pollutants to vibrate, collide, and adhere together in clusters of sufficient size for removal from the gas phase in a secondary separator such as a cyclone.

Variables that control Nord[4] has discussed an equation developed by Brandt, Freund and Hiedemann which describes the action of aerosols in a sonic field. This equation shows that the vibration of a particle approaches that of the gas more closely (1) the lower the frequency, (2) the smaller the particle, (3) the lower its density, and (4) the higher the gas viscosity. Ordinarily only the first two of these factors are commercially important. As air-borne pollutants ordinarily consist of particles covering a range of particle sizes, the largest particles move relatively little while the smallest particles move at almost the velocity of the gas in which they are suspended. The greater the sound intensity causing the vibration, the greater is the energy of impact between particles.

Best frequency range At any given sound intensity there is an optimum frequency for each particle size which gives the greatest relative motion for an aerosol containing a range of particle sizes. Hence, the optimum frequency may cover a rather broad range. That the particles of different sizes will be vibrating at different velocities in the optimum frequency range means that the maximum number of collisions between particles will occur, more than if all of the particles were of the same size and all partook of the same vibration.

There is also a hydrodynamic factor, based upon Bernoulli's principle, which is of lesser importance in the sonic agglomeration of aerosols. According to this concept, if the line of centers of two particles is perpendicular to the sound field, then at times the velocity of the gas between them will be greater than in other parts of the gas. Therefore, the pressure between them will be reduced, and they will move together. This is of importance and will result in collision only when the particles are close together, as when the aerosol concentration in the gas is high.

A third factor affecting aerosols in a sound field is the radiation pressure effect, caused by difference in momentum of the gas on opposite sides of a particle. Although this sound radiation pressure can be of considerable magnitude and can support small objects in mid-air, it is not of great importance in agglomerating pollutants, because of the short contact time usually encountered in the agglomeration chamber.

Needs secondary collector The primary function of a sonic agglomerator is to agglomerate the aerosol particles into larger particles of sufficient size to permit their removal from the gas in a secondary collector. Little separation of the pollutants from the gas is effected in the agglomerator itself. Among the secondary collectors which can be used are: (1) small-diameter, high-velocity cyclones assembled in parallel; (2) large-diameter, lower-velocity cyclones, perhaps assembled in series; (3) impingement separators; (4) scrubbers in which the gas is contacted with water or other liquid; or (5) combinations of two or more of these secondary collectors. As the collection efficiencies of all of these collectors depend to a large extent upon the particle size of the material to be collected, it is apparent that the greater the collection efficiency of the secondary collector, the less need there is for a high degree of agglomeration of the pollutant. With centrifugal collectors such as cyclones and scrubbers, high collection efficiencies are associated with high pressure drops through the collector; hence, for a given overall collection efficiency, an economic balance must be attained between the cost of agglomerating the aerosol and the cost of removing the agglomerated material from the gas.

For commercial application of sonic agglomeration, and high agglomeration and collection efficiency, an optimum combination of frequency, sound intensity, and contact time is required. It has been shown, theoretically and in practice, that lower frequencies are generally more effective in agglomerating aerosols than are higher frequencies; in fact, it has been shown that audible frequencies in the range of 1,000 to 4,000 cycles per sec. are more effective than are the truly ultrasonic frequencies. However, the frequency which will be most effective for any particular agglomeration application, involving a particular system and a given set of operating conditions, cannot be calculated exactly. Instead, it must be determined from actual plant operating data. This is not a serious disadvantage, since commercial sound generators can be operated over a sufficiently wide frequency range to permit operation at the optimum frequency.

Although exact relationships cannot be predicted without actual operating data, it is known that as sound intensity is decreased, contact time must be increased in order to maintain any given collection efficiency. This obviously means that an economic balance must be attained between operating costs (sound intensity) and fixed charges on capital investment (equipment size, determined by contact time).

Optimum conditions

For effective agglomeration, a minimum concentration of the pollutant is required to achieve a satisfactory number of particle collisions and consequent agglomeration. On the other hand, too high a concentration of the pollutant can result in loss of sonic energy because of attenuation of the sound within the aerosol. In general, for collection efficiencies as high as perhaps 95 percent, low grain loading can be overcome by increased contact time in the agglomerator, thus maintaining the same chance of particle collisions.

The particle collection efficiency of a sonic agglomeration system can be increased by introducing a fine spray of water into the agglomeration chamber. This is because the possibilities for particle collisions are thereby increased. Addition of solid particles, as by recycle of material already removed from the gas, may also increase the over-all collection efficiency for the same reason.

How readily pollutant particles will adhere together after collision is of great practical importance. In general, particles in aerosols formed by dispersion, such as smokes, will stick together more readily than will more or less rounded particles formed by attrition, as in dusts. In addition to increasing the particle concentration, water sprays often wet dust particles and thus aid in their agglomeration. How well particles of a given material will adhere together, and the minimum concentration required for effective agglomeration, can be determined only by experiment and not from purely theoretical considerations.

For carbon black

An example of the relationship which can exist between the collection efficiency E, the grain loading G, the contact time T and the sound intensity W, is the following equation which is typical of the sonic agglomeration and collection of carbon blacks by a siren-type agglomerator:*

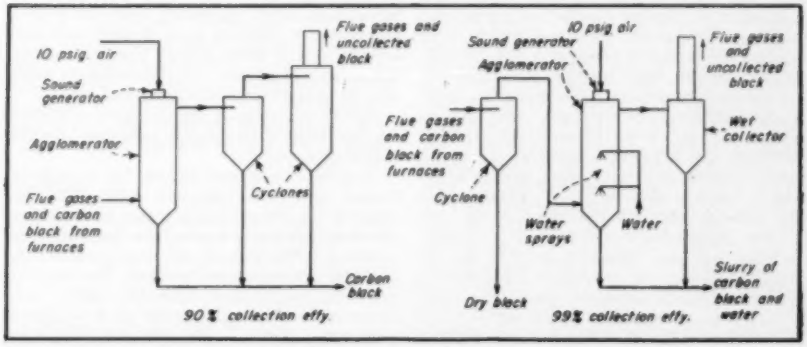
$$\log (100 - E) = k/(GT\sqrt{W})$$

where k is a constant depending upon the frequency, the type of black, and the agglomeration and collection system.

Sound generator types

Devices for the generation of sound in gaseous media have been reviewed by Stokes[4] and others, and fall into three groups: (1) piston, (2) whistle, and (3) siren. The piston-type sound generator includes magnetostriction devices, electromagnetic devices, and crystals such as quartz and barium titanate, that vibrate by the piezoelectric effect. Crystals of barium titanate, basically a ceramic, can be regularly oriented and formed into large pieces of almost any desired shape. Although they are limited to temperatures below 100 deg. C., barium titanate crystals produce much larger amounts of power at a given voltage than do other piezoelectric crystals. They are essentially low-power-output devices, however, and have not been used on a large commercial scale. They have an advantage over the whistle and siren types in that there is no dilution or contamination of the gas stream.

Whistles, such as a Hartmann whistle or an organ pipe, have such low efficiencies that they



Flow diagrams, at left for dry, and at right for wet, sonic agglomeration of carbon black; note higher efficiency for wet type, which comes from the increase in possibilities of particle collisions.

are of no interest for commercial sonic agglomeration.

A siren-type sound generator consists essentially of a siren with a rotor and a stator with matching ports around the periphery of each. As compressed gas flows through the siren, the ports in the stator are alternately opened and closed by the turning rotor and the gas flow is "chopped", producing high-intensity sound which is directed by an acoustic horn into the agglomerating chamber. The sound intensity is determined by the pressure of the compressed gas, while the frequency is controlled by the speed of the rotor. Units of this type, manufactured by the Ultrasonic Corp., can develop large amounts of power and are being used successfully in large commercial installations for the agglomeration of sulphuric acid fog, sulphur dust, molybdenum dust, carbon black, and soda ash.

Sonic agglomerators, particularly of the gas-siren type, can be considered for agglomeration of air pollutants prior to their removal in collectors such as cyclones or impingement separators. A number of successful commercial sonic agglomerators are now in operation and the gaps existing in our knowledge of the effect of operating variables and process conditions on sonic agglomeration are being filled in rapidly.

How costs compare

When compared to an electrostatic precipitator, a siren-type sonic agglomerator has a lower first cost, although it is somewhat more expensive to operate. Both economic and engineering studies must be made of the relative merits and costs of the two units. The sonic collector has an additional advantage over the electrostatic precipitator in that it can be used to agglomerate and collect substances which will not take an electrostatic charge. Molybdenum sulphide dust is an example.

Needs economic study

By the use of sufficiently high power input or sufficiently long contact time in the agglomerator, almost any desired degree of pollutant agglomeration can be obtained. The optimum combination of sound intensity and contact time can be determined only by an economic study based upon adequate data on optimum frequency, pollutant concentration, and ease of agglomeration. Then the sonic agglomeration and collection system must, in turn, be compared on an engineering and economic basis to other systems for the removal of gas pollutants. It is believed, however, that many new and varied applications of sonic agglomeration will be brought forward in the near future.

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Note: Additional literature references given in 3, 4, and 5 above.

Adsorption Can Control Odors

Activated carbon is finding increasing use in preventing air contamination by odorous and toxic compounds.

AMOS TURK and K. A. BOWNES, W. B. Connor Engineering Corp., Danbury, Conn.

In the collection of air-borne pollutants by by adsorption, the polluted air is passed through a granular bed of solid adsorbent (activated carbon). The pollutants are removed by physical or chemical adsorption on the surface of the adsorbent. When the adsorbent has become saturated, it is removed, reactivated and replaced.

Adsorption limits

There are two basic requirements which fix the dimensional extremes of adsorbable air-entrained pollutants. For the upper limit, the individual particles of the contaminant must be sufficiently small so that their Brownian or kinetic velocities will insure effective contact by collision between them and the granular adsorbent. Although this will generally limit the particle size of adsorbable pollutants to molecular dimensions, it also allows moderately efficient adsorption of some very fine mists, such as those produced by condensation of vapor from evaporated liquids, for example heated oils.

The lower limits of molecular sizes are imposed by the requirement that the pollutant, if it is to be removed by physical adsorption, must be higher in molecular weight than the normal components of air. In general, removal of gaseous pollutants by physical adsorption is practicable for gases with molecular weights over 45. This includes almost all the odorous and toxic gaseous air pollutants. Odorous gases of lower molecular weight, such as formaldehyde, chlorine and ammonia, may be removed by chemisorption methods, using appropriately impregnated carbon.

Why carbon is better

Activated carbon is the preferred adsorbent for the removal of gaseous pollutants for the following reasons:

1. Suitably activated carbon has a high retentive capacity for gases and vapors. This "retentivity"[6] is defined as the maximum weight of adsorbed pollutants retained by the carbon on exposure to the ambient air, and represents the *practical* capacity of the sorbent. For most air pollution applications, activated carbon will retain at least 15 to 20 percent of its weight of pollutants. Table I lists the retentivities of some representative gaseous or vaporous pollutants.[6]

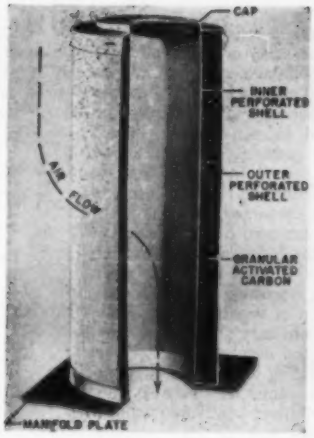

Fig. 1—Cutaway view of carbon canister.

Fig. 2—Large canister installation preventing release of odors.

Table I—Retentitivies of Some Gaseous Pollutants

Pollutant	Retentivity, Wt. Percent Using Activated Carbon at 20 Deg. C. and 760 Mm. Hg
Methyl mercaptan	20
Ethyl mercaptan	23
Butyric acid	35
Acrolein	15
Indole	25
Skatole	25
Putrescine	25
Benzene	24
Toluene	29
Phenol	30

Table II—Specifications for Gas Adsorption Carbon

Property	Specification
Retentivity for CCl_4, 20 deg. C., 760 mm.	At least 30 percent
Apparent density	At least 0.45 g./ml.
Hardness (ball abrasion)*	At least 80 percent
Mesh distribution	6-14 range (Tyler)

* Percent of 6-8 mesh carbon which remains on a 14-mesh screen after vibrating with 30 steel balls of 0.27-0.27 in. diam. per 50 g. carbon, for 30 min.

Retains no water

2. Activated carbon, unlike oxygenated sorbents such as silica gel or activated alumina, is non-polar. Therefore, it has no retentivity for water vapor. Thus the presence of moisture in the polluted air in no wise affects the effectiveness or efficiency of the purification process.

Table II lists the specifications of a gas adsorption carbon suitable for air purification.

Equipment and engineering for the application of activated carbon to air purification must combine efficient removal of the pollutants for a reasonably extended time, with low resistance to air flow. This requires an adequate amount of granular carbon arranged in thin beds, coupled with a linear air flow rate through the beds that will insure sufficient duration of contact between polluted air and sorbent. Figs. 1 and 3 illustrate, respectively, a carbon canister and a carbon cell—both designed to meet these requirements.

Capacity of standard units

The carbon canister illustrated will effect the purification of 25 cfm. of polluted air, with a pressure drop of 0.15 in. of water column. Multiple canisters to decontaminate any desired volume of polluted air are mounted on manifold plates in such arrangement as to insure uniform distribution of the air over all the carbon surface. A single carbon cell will purify 700 cfm. of air under the same conditions, and banks of such cells arranged in either flat or V arrangement are suitable for larger air volumes.

For either type of equipment, the efficiency of adsorption will be at least 95 percent until the carbon has adsorbed between 15 and 20 percent of its weight of pollutants. After that it will then fall off gradually as saturation increases. The carbon requires reactivation when adsorp-

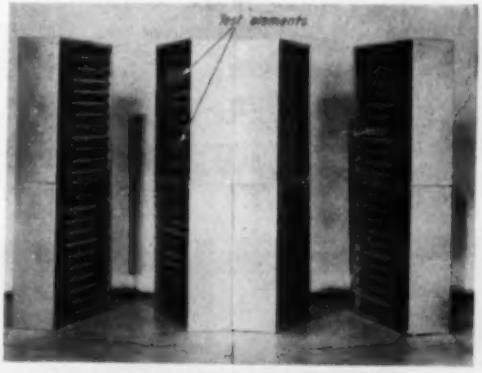

Fig. 3—For larger installations carbon cells (700 cfm. per cell) can be arranged flat or in V arrangement, as here.

NOMENCLATURE

- a = Proportionate saturation of carbon when adsorption efficiency falls below 95 percent. Usually 0.15 to 0.25. See Table I.
- C_v = Volume concentration of pollutants, ppm.
- C_w = Weight concentration of pollutants, lb. per 10^6 cu. ft. air.
- h = Service life of carbon, hr.
- M = Average molecular weight of pollutants.
- r = Air flow, cfm.
- w = Total weight of carbon in installation, lb.

tion efficiency has dropped to a value at which the effluent air remains polluted to a degree exceeding the odor or toxicity threshold of any pollutant.

What is service life

The service life of activated carbon air purification installations may be calculated from the formula:

$$h = \frac{1.67\ (10)^4\ aw}{r\ C_o} \qquad (1)$$

To determine when an activated carbon adsorption installation will require reactivation, laboratory analysis for the degree of saturation is necessary. After some known initial period of service, the exact extent of which is not critical, one canister from a multiple canister installation, or the rectangular test element supplied with a carbon cell installation is removed and returned to the laboratory for analysis. The removed test canister can be replaced with a substitute, but the carbon cell element needs no replacement unless future tests may be required. Laboratory analysis reveals the proportionate saturation of the carbon (a in Eq. 1) up to the time h of removal of the test element, and will, therefore, give C_o. Assuming that C_o remains constant, and assigning an appropriate terminal value for a (retentivity), the total expected service life may be calculated.

Reactivation of saturated carbon necessitates removal of the carbon from its container and subjecting it to controlled desorption with superheated steam at temperatures over 1,000 deg. F. until its initial activity has been regained.

What odors can be adsorbed

There are many industrial or chemical processes which create odor nuisances by pervading the surrounding atmosphere with highly offensive odorous substances. Frequently these odorous pollutants are in such dilute concentration that adsorption is the most effective or the only method for abatement. An example may be cited[3] in which sulphurous vapors incidental to the handling of sodium dithioformate (synthesis of Vitamin B_1) were the major offending pollutants. This pollution had a pervading and enduring sulphide stench, and was successfully removed only by a multiple activated carbon canister installation. Other cases of highly offensive or toxic adsorbable pollutants include nitrogenous odors from animal putrefaction, irritants produced from oil oxidation and decomposition, odorous organic and inorganic acids, solvent vapors, and the war gases, including the new and powerful "nerve gases." In all such cases, it is advisable first to determine the concentration of offending vapors in the air, either from operating records or by an activated carbon adsorption test as described in the following section. Such investigation may disclose that means for washing, cooling, filtering, etc., are necessary in addition to the adsorption of vapors. Furthermore, such special applications may also require engineering consultation and development.

Test apparatus

An apparatus consisting of dual activated-carbon-filled adsorption canisters, assembled integrally with a motor-driven air blower, constitutes an ideal collecting unit for the determination of concentrations of gaseous air pollutants in an atmosphere under investgation. After the unit has been in operation in the suspect atmosphere for the required length of time, the carbon is removed and analyzed for its nonaqueous adsorbate. The degree of contamination may then be calculated by solving for C_o in Eq. (1), as previously explained.

The concentration of pollutants in ppm. by volume (C_v), if desired, may be determined if their average molecular weight M is known. Then, at normal atmospheric conditions of 70 deg. F. and 760 mm. Hg barometer,

$$C_v = 386 C_o / M \qquad (2)$$

For pollutant study

Reactivation or desorption of the exposed carbon may also serve to isolate samples of the pollutants for further study, tracing pollutants to sources, and similar useful purposes.

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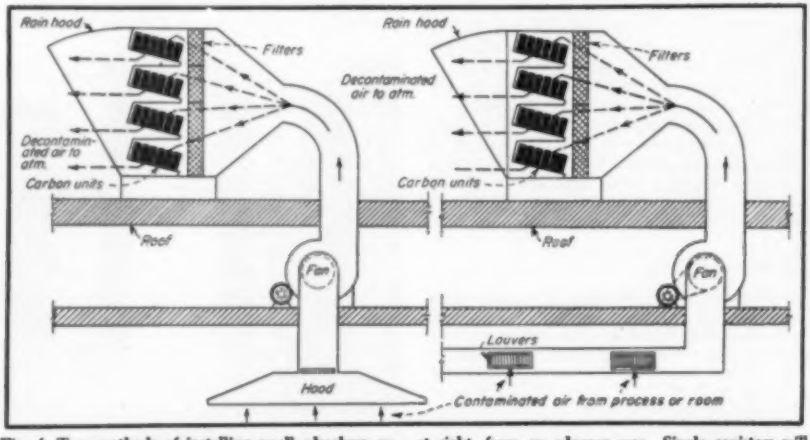

Fig. 4—Two methods of installing small adsorbers on roofs: at left, drawing contaminated air from a hood, at right, from an odorous area. Single canisters will handle 25 cfm.

HELP FIND THE WINNER OF THE 11th AWARD FOR

CHEMICAL ENGINEERING ACHIEVEMENT

- What company in the chemical process industries has contributed most to the advance of chemical engineering since 1948?
- What has been the nature of its industrial achievement?
- Has it been the result of group effort—engineering and research, production and sales, management and administration?
- To what extent have chemical engineers participated in the development?

Chairman Alfred H. White and his committee of 69 distinguished educators again seek your cooperation in answering the questions above and thereby furthering a worthy project of our profession—the 11th Award for Chemical Engineering Achievement. Your nominations and suggestions will greatly help in selecting the company, subsidiary, or department within a company to be honored during the biennial Exposition of the Chemical Industries, in New York City, Nov. 26-Dec. 1, 1951.

Plans for this unique series of awards were first announced in this magazine in May 1933. In contrast to most medals and similar citations, the Chemical Engineering Award is presented to a company rather than to an individual. Its primary purpose is to recognize group effort—particularly the achievements that result from teamwork between management and technology in a corporate organization. Thus it focuses public attention on those progressive companies that have encouraged their chemical engineers to participate broadly in all of the affairs of the process industries.

Here Are the Rules and Regulations

PURPOSE

The Award for Chemical Engineering Achievement is made to recognize group effort of a corporate organization —of executive, engineering, research, production and sales divisions. It therefore serves a dual purpose of recognizing an outstanding group achievement and at the same time calling attention to those progressive companies that have encouraged their chemical engineers to participate broadly in all of the affairs of the process industries.

COMMITTEE OF AWARD is under the chairmanship of Professor-Emeritus Alfred H. White, University of Michigan (turn page)

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QUALIFICATIONS

The 11th Award for Chemical Engineering Achievement will apply only to industrial developments that have come into commercial fruition or have become known publicly since January 1948. All nominations should be received by July 15, 1951, and should contain the following information:

(a) What is the nature of the company's achievement?
(b) During what period has it come into commercial fruition?
(c) To what extent have chemical engineers participated in its development?
(d) What supplementary records, data, articles or references are pertinent to a fair consideration of this achievement and of the company's attitude toward its chemical engineers?

JUDGES

The Committee of Award shall consist of the heads of chemical engineering in all of the educational institutions of the United States whose courses are now accredited by the American Institute of Chemical Engineers and the Engineers' Council for Professional Development. Dr. Alfred H. White, Professor-Emeritus of Chemical Engineering at the University of Michigan, and member of the Award Committee since its inception in 1933, will continue to serve as chairman. S. D. Kirkpatrick, editorial director of *Chemical Engineering*, will again be secretary of the Award Committee, but without vote.

TEN AWARDS
have been made since 1933, eight to individual companies and two to the groups of organizations most responsible for outstanding wartime achievements—the American synthetic rubber industry and the atomic bomb project. Here is the honor roll of these citations ——→

THE AWARD

The award will consist of an appropriate bronze plaque suitably engraved to indicate the nature of the achievement and the name of the company to be honored. The award will be presented at a dinner of the chemical engineering profession to be held in the Waldorf-Astoria Hotel in New York the evening of Wednesday, Nov. 28, 1951.

SUGGESTIONS

This award is not restricted to those companies that file formal applications with the committee. Suggestions are desired from any and all sources that will assist the committee in directing attention to industrial groups that should have its consideration. Communications may be addressed, in confidence, to:

S. D. KIRKPATRICK, *Secretary*
Committee of Award
Room 2400
330 West 42nd St.
New York 18, N. Y.

COMMITTEE OF AWARD consists of the heads of chemical engineering in all the educational institutions of the United

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J. A. TAYLOR, Wayne
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W. M. VON FISCHER, Case

1933 Carbide & Carbon Chemicals Corporation—the original award was made for producing commercially a large number of synthetic organic chemicals from petroleum and natural gas.

1935 E. I. du Pont de Nemours & Co., Organic Chemicals Dept.—for the successful industrial development of neoprene, synthetic camphor and of certain other important organic chemicals and dyestuffs.

1937 Monsanto Chemical Company—for developing the large-scale production and utilization of elemental phosphorus which has since been the basis of a great inorganic chemical industry.

1939 Standard Oil Development Company—for new chemical engineering processes and equipment to make available super-fuels for aviation, as well as other valuable products synthesized from the hydrocarbons of petroleum.

1941 The Dow Chemical Company—for the recovery from sea water of magnesium metal sorely needed for aircraft and munitions.

1943 American Synthetic Rubber Industry—67 companies were honored for crowding into 24 months a project that in normal times would have required a dozen years—a miracle of engineering planning and construction.

1946 The Atomic Bomb Project, including 122 companies, universities and research organizations—for contributing as prime contractors so significantly to the scientific research and engineering that were responsible for the success of this war-ending achievement.

1947 Merck & Co.—for successful pioneering in the large-scale production of streptomycin and other vital medicinals, and, in a broader sense, a tribute to a new technology, Biochemical Engineering, for distinguished service to humanity.

1948 Shell Development Company—for the successful synthesis of glycerine from petroleum for the first time on a commercial scale.

1949 Celanese Corporation of America—for the chemical engineering integration of its textile, plastics and chemical operations.

States with courses accredited by American Institute of Chemical Engineers and Engineers Council for Professional Development.

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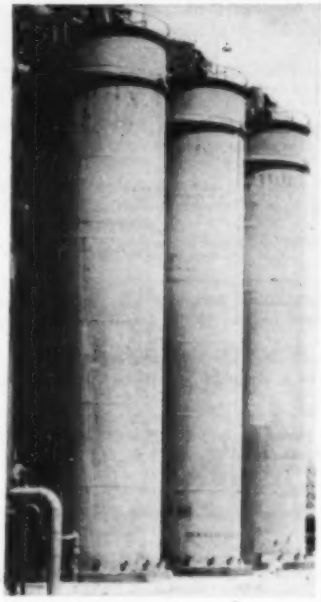
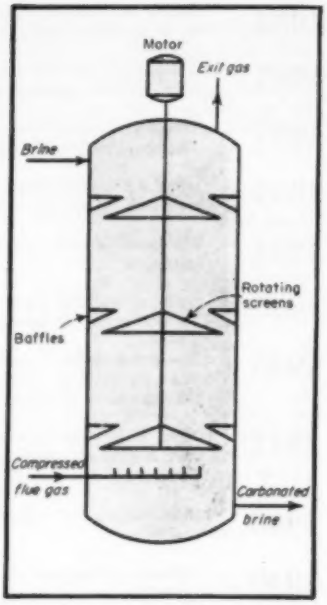
SEARLES LAKE LOWER BRINE

Component	%
KCl	2.94
Na_2CO_3	6.78
$Na_2B_4O_7$	1.96
Na_2SO_4	6.56
NaCl	15.51
Na_2S	0.38
Li_2O	0.006
K Br	0.08
WO_3	0.004
I_2	0.002
P_2O_5	0.044
F	0.002

THE PROBLEM: Recovery of soda ash associated with a myriad of other salts.





THE ANSWER: Carbonation. Low-pressure carbonators are only 70 ft. high. Low CO_2 in flue gas demands efficient contacting to avoid excessive pressures and heights.

New Carbonation Technique →

Exceedingly fine bubbles are key to problem of contacting dilute

J. V. HIGHTOWER

Carbonation of Searles Lake lower brine in a recently-completed $5-million installation at Trona, Calif., is responsible for a boost of 60,000 tons per year of natural soda ash, and 30,000 tons per year of borax. The new technique is the latest step in an evolution that was accelerated in 1927, when American Potash and Chemical Corp. took over the operation of the facilities at Trona from the American Trona Corp. It represents the first exploitation of the lower brine bed, which is richer in soda ash than the upper (6.78 vs. 4.8 percent), covers a greater area (36 vs. 12 sq. mi.), but is not as deep (35-40 vs. 60-90 ft.).

The new technique has not been applied to the upper brine bed. Upper brine is now being processed for soda ash and other salts with the aid of some ingenious design features and operating tricks to be described soon in another article.

Motor-driven, multi-stage impellers in open-end casings draw the brine up into pipelines, which are insulated to prevent excessive solar heating of the brine on its way to the plant several miles distant.

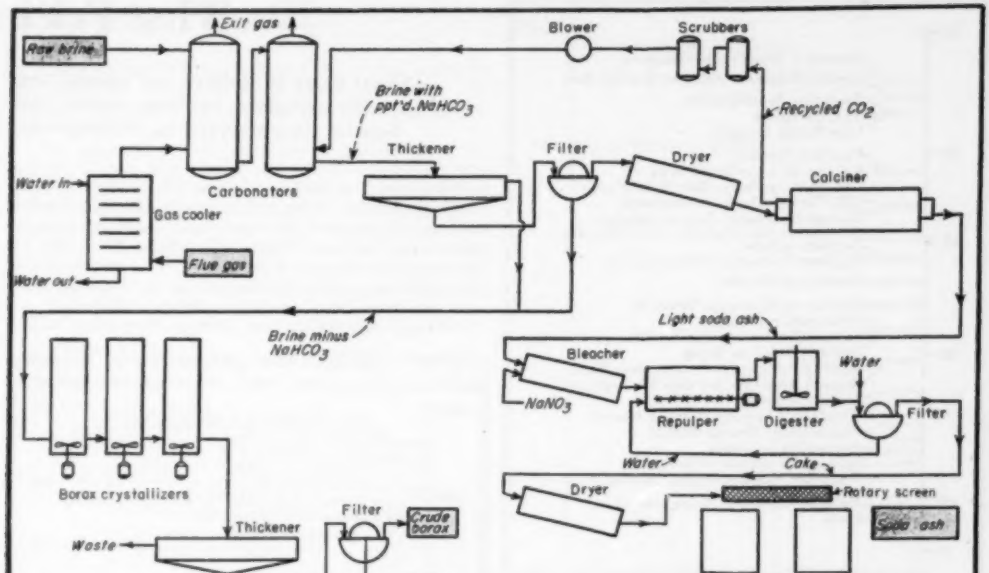
THE CARBONATORS

In the carbonating towers, sodium carbonate in the brine is contacted with carbon dioxide gas for conversion to the relatively insoluble sodium bicarbonate, which is then thickened, filtered, dried, and calcined to produce soda ash.

There are six carbonators. In the primary bank of three towers, brine enters each at the top and descends countercurrently through an up-moving, dispersed volume of boiler house flue gas. Brine effluent from the bottom of each tower is then discharged into the top of each of three towers comprising the secondary bank of carbonators. Carbon dioxide gas supplied to the bottom of these secondary units is the gas produced when the sodium bicarbonate is calcined.

Boiler flue gas to the primary carbonator towers averages around 10 to 12 percent CO_2. This is a relatively dilute concentration and would normally call for a high compression system or unusually tall towers for the necessary contact time between brine and CO_2. This problem was solved by a method whereby the gas moving up through the towers is dispersed in exceedingly fine bubbles. Each tower contains three circular, rotating gas-distributing screens mounted on a shaft driven by a motor mounted on top of the tower (see cut). The incoming flue gas enters beneath the lowest screen and in its upward move-

J. V. HIGHTOWER is West Coast Editor of Chemical Engineering. His second article about operations at Trona will appear soon.



THE PROCESS: Carbonation produces the bicarbonate which is relatively insoluble. The bicarbonate is separated and calcined back to the carbonate, which is then bleached and densified. Filtrate is crystallized to yield the crude borax coproduct.

More Natural Soda Ash

carbon dioxide (10–12% in flue gas) and brine in inexpensive equipment.

ment is churned thoroughly through the three rotating screens submerged in brine. By this means it is possible to carbonate in low pressure towers of simple construction only 70 ft. high.

As the carbonating towers are subjected to the corrosiveness of the lower level brine, (which contains approximately four times as much sulphide as the upper brine) the towers are stainless-lined. The rotating screens and most of the piping are of stainless material.

BLEACHING AND DENSIFYING

Bicarbonate from the calciner is slightly discolored with organic matter. In order to bleach the product it is fed, along with a small quantity of sodium nitrate, into one end of a bleaching chamber countercurrent to the hot gases from an oil-fired burner at the opposite end of the rotating chamber. The product is white, light ash.

Because the light ash is not the most satisfactory form for certain uses the product is then slurried and fed into a repulping chamber, then into a digester where further agitation occurs. The resulting slurry of crystalline sodium carbonate monohydrate is passed over rotary filters where the crystals are separated and filtrate is returned to the repulper. The cake is charged into a rotary kiln dryer to produce the finished soda ash.

After the carbonation process, the liquor from the thickener and the filters is mixed with some raw brine to reduce the solubility of the borax in the liquor, then cooled to 68 deg. F. in vacuum crystallizers where ammonia is used as a refrigerant in the second and third stages. The material is pumped to a thickener. The borax slurry from the thickener is then discharged to a rotary filter, and the crude borax cake is conveyed to the borax plant for refining.

Soda Ash Production at Trona—1950 Tonnage Is Higher than 1949 and This Reflects Increase Due to New Carbonation Plant.

Year	Tonnage
1934	6,419
1935	22,458
1936	32,426
1937	39,830
1938	51,054
1939	47,732
1940	51,821
1941	31,312*
1942	42,768
1943	54,211
1944	70,120
1945	82,008
1946	86,266
1947	89,659
1948	99,202
1949	119,372

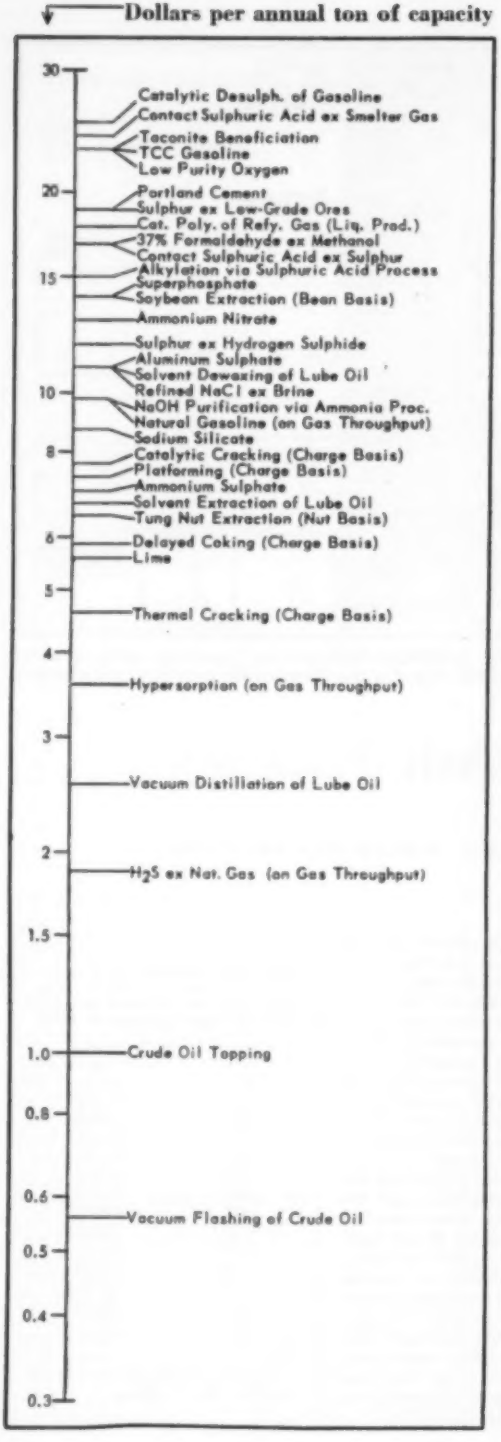
* Plant closed for over three months due to strike.

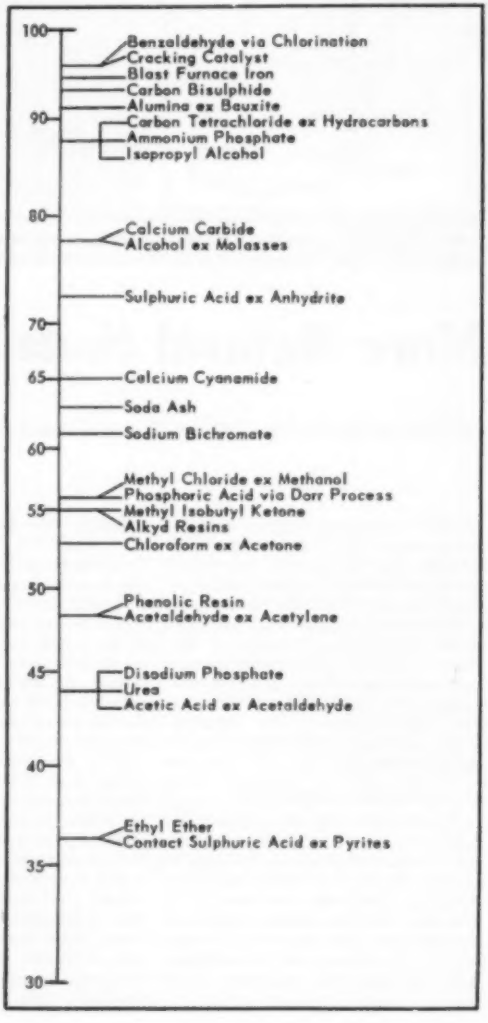
What Price

Plant costs in dollars per annual ton of capacity are given in these charts. All figures are corrected to 1950 levels.

A knowledge of capital cost is essential in any economic study of chemical plants and processes. Although detailed estimates are required for some studies, in many cases an off-the-cuff, high-spot figure will suffice. With this in mind, we have brought together here, in a single convenient collection, capital investment data for over 125 products and processes of interest to chemical engineers.

Although information was obtained from many widely

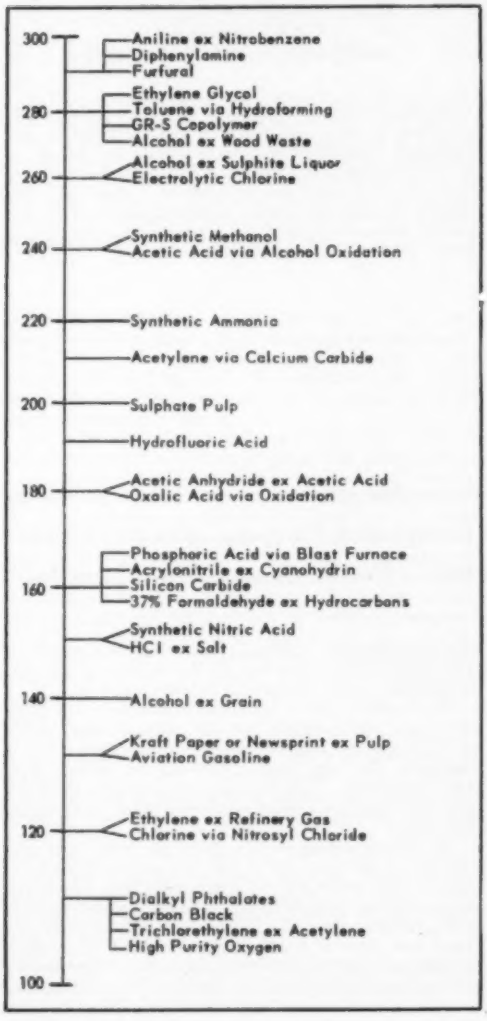


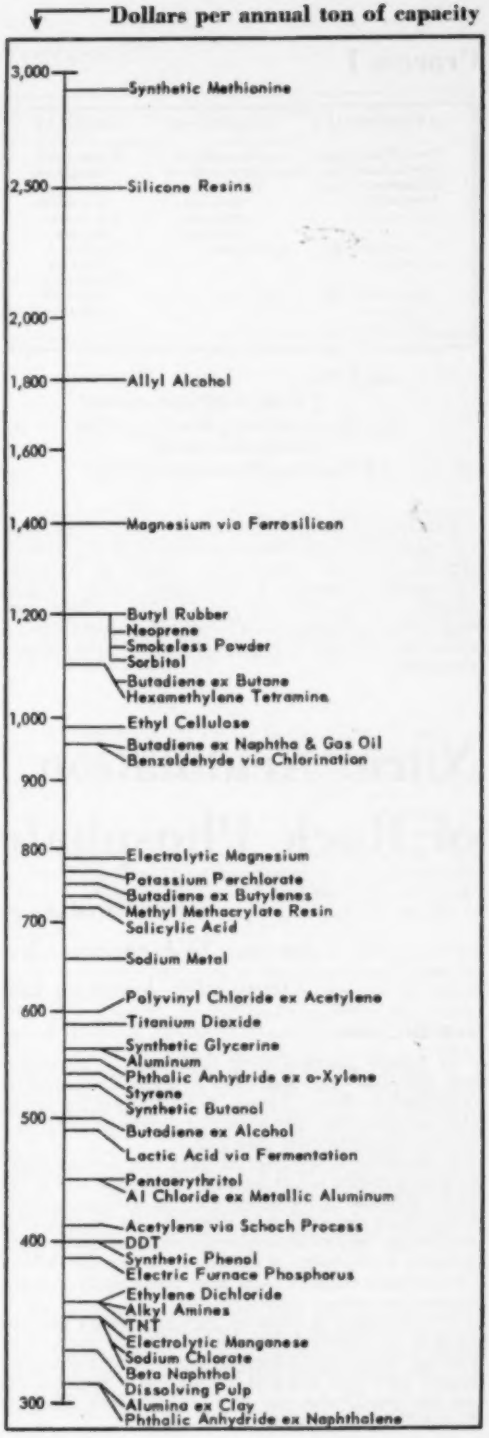


Process Plants?

scattered sources, a good nucleus of data was provided by two particular references: Faith, Keyes, and Clark, "Industrial Chemicals," Wiley, 1950; and Wilcoxon, *Chemical Engineering*, May 1947, p. 112.

The figures given here represent typical commercial size plants. Where data were available over a range of plant sizes for a particular product, the reported unit cost was taken at the middle of the range. If the size range of commercial plants is very broad and the logarithmic cost vs. capacity curve is flat (say, less than 0.7 slope), the unit cost over the range might vary twofold or more from the smallest plant to the largest plant. Obviously, therefore, no high degree of accuracy is claimed.





Process I

RAW MATERIALS	PROCESSING	PRODUCTS
Rock Phosphate Nitric Acid Phosphoric Acid Ammonia	Acidulation Ammoniation Potassium chloride addition (optional) Drying	Dicalcium phosphate Ammonium phosphate Ammonium nitrate Calcium fluoride Potassium chloride (optional)

$$Ca_{10}F_2(PO_4)_6 \xrightarrow{16\,HNO_3 + 4H_3PO_4\ (acidulation)} 6H_3PO_4 + 2Ca(H_2PO_4)_2 + 8Ca(NO_3)_2 + 2HF \quad (1)$$

$$\xrightarrow{17\,NH_3\ (ammoniation)} 9CaHPO_4 + NH_4H_2PO_4 + 16NH_4NO_3 + CaF_2 \quad (2)$$

Extraction of rock phosphate with a mixture of nitric and phosphoric acids, ammoniation, addition of potassium chloride (optional), and drying. Similar to the I. G. Farbenindustrie process. Product grades include 17-22-0, 14-28-0, 12-35-0, 14-14-14, and 11-22-11. About one-third as much phosphoric acid is required per pound of rock phosphate as would be required for making triple superphosphate.

Process II

RAW MATERIALS	PROCESSING	PRODUCTS
Rock Phosphate Nitric Acid Sulphuric Acid Ammonia	Acidulation Ammoniation Potassium chloride addition (optional) Drying	Dicalcium phosphate Calcium sulphate Ammonium nitrate Ammonium phosphate Calcium fluoride Potassium chloride (optional)

$$Ca_{10}F_2(PO_4)_6 \xrightarrow{12\,HNO_3 + 4H_2SO_4\ (acidulation)} 6H_3PO_4 + 4CaSO_4 + 6Ca(NO_3)_2 + 2HF \quad (3)$$

$$\xrightarrow{13\,NH_3\ (ammoniation)} 5CaHPO_4 + NH_4H_2PO_4 + 4CaSO_4 + 12NH_4NO_3 + CaF_2 \quad (4)$$

Process II involves extraction of the rock phosphate with a mixture of nitric and sulphuric acids, followed by ammoniation, addition of potassium chloride and drying. It is similar to the PEC process. Typical product grade is 11-11-11. Sulphuric acid requirement is about half that needed for making ordinary superphosphate. TVA has studied Processes I and II in a 4-ton-per-day pilot plant. Several hundred tons have been made.

Nitric Acidulation of Rock Phosphate

Four fertilizer processes that are now economically promising for us. TVA engineers have transplanted European ideas and enriched them with American know-how. Result: cheaper, better plant food.

T. P. BIGNETT

In Europe processes using nitric acid to decompose rock phosphate have been used in large-scale production of fertilizer for about 20 years. In this country, interest in these processes has been increasing directly as nitric acid production capacity has increased.

A fundamental advantage of nitric acid decomposition of rock phosphate is that the cost of the nitric acid is offset by the value of the nitrogen in the fertilizer product. Furthermore, the expense of sulphuric acid, fuel, or electrical energy used for decomposing rock phosphate in other processes is eliminated or decreased. It logically follows that fertilizers could be made more economically by combination processes involving acidulation of rock phosphate with nitric acid rather than by the separate preparation of phosphatic and nitrogenous fertilizer materials.

Other advantages of combination processes: (1) products more concentrated than the usual fertilizer mixes, and (2) the combination products are homogeneous in the sense that each granule contains the several plant-food ingredients. This homogeneity precludes the segregation of ingredients which sometimes occurs in dry-mixed fertilizers.

Simple acidulation of rock phosphate with nitric acid, however, is not the answer. The fertilizer produced is not conveniently usable since it is extremely hygroscopic, corrosive, and too unstable to dry. The more promising nitric acid processes consist of acidulation of rock phosphate with nitric acid alone or in admixture with either sulphuric or phosphoric acid, followed by ammoniation. The presence of very hygroscopic calcium nitrate in the final product is avoided by the use of appropriate proportions of phos-

T. P. HIGNETT is *Chief of the Development Section, Division of Chemical Engineering, TVA. Industry is showing considerable interest in the work he and his colleagues have been doing at Wilson Dam, Alabama, under the over-all direction of J. H. Walthall, Chief of Research and Engineering.*

Process III

RAW MATERIALS	PROCESSING	PRODUCTS
Rock Phosphate Nitric Acid Ammonia	Acidulation Ammoniation Potassium sulphate addition Drying	Dicalcium phosphate Ammonium nitrate Potassium nitrate Calcium sulphate Calcium fluoride Potassium sulphate

$$Ca_{10}F_2(PO_4)_6 \xrightarrow{20\,HNO_3\ (acidulation)} 6H_3PO_4 + 10Ca(NO_3)_2 + 2HF \quad (5)$$

$$6H_3PO_4 + 10Ca(NO_3)_2 + 2HF \xrightarrow{14\,NH_3\ (ammoniation)} 6CaHPO_4 + 14NH_4NO_3 + 3Ca(NO_3)_2 + CaF_2 \quad (6)$$

Involves extraction with nitric acid followed by ammoniation and admixture of potassium sulphate and drying. This process is similar to Process II except that the required amount of sulphate is derived from potassium sulphate rather than sulphuric acid. Processes III and IV have been studied in small-scale engineering equipment. Evidence is sufficient to prove technical feasibility. Pilot-plant study is planned for the near future.

Process IV

RAW MATERIALS	PROCESSING	PRODUCTS
Rock Phosphate Nitric Acid Ammonia	Acidulation Ammoniation & Filtration	Dicalcium phosphate Calcium fluoride
	NH_3 & CO_2	Calcium carbonate
	Filtration	Ammonium nitrate solution

$$Ca_{10}F_2(PO_4)_6 \xrightarrow{20\,HNO_3\ (acidulation)} 6H_3PO_4 + 10Ca(NO_3)_2 + 2HF \quad (7)$$

$$6H_3PO_4 + 10Ca(NO_3)_2 + 2HF \xrightarrow{14\,NH_3\ (ammoniation)} 6CaHPO_4 + 14NH_4NO_3 + 3Ca(NO_3)_2 + CaF_2 \quad (8)$$

Extraction with nitric acid, ammoniating to precipitate dicalcium phosphate which is separated by filtration. Filtrate treated with CO_2 and NH_3, resultant $CaCO_3$ separated by filtration or sedimentation. Solid ammonium nitrate is produced from the solution by evaporation and crystallization, graining, or prilling. Thus, two products are made, an impure dicalcium phosphate (about 35 percent P_2O_5) and ammonium nitrate (34 percent N).

phoric or sulphuric acid—or by other means. The products contain ammonium nitrate, dicalcium phosphate, ammonium phosphate, and sometimes other compounds, depending on the process used. These chemical compounds are effective fertilizer materials and are present in most mixed commercial fertilizers.

Following are believed to be the most important of the nitric acid-rock phosphate processes used commercially:

1. A process used by the Odda Smeltwerke (Norway) and the Netherlands State Mines (Holland) involves (1) extracting rock phosphate with nitric acid, (2) separating out a sufficient portion of the calcium nitrate by cooling and crystallization so that the mole ratio of CaO/P_2O_5 in the remaining solution is 2.0 or less, (3) ammoniating the solution to convert the nitrate to ammonium nitrate and the phosphate to dicalcium phosphate and ammonium phosphate, and (4) drying the ammoniated slurry or paste to produce a nitrogen-phosphorus fertilizer, typically a 20-20-0* grade. The calcium nitrate that is crystallized in Step 2 is dehydrated and marketed separately.

2. A process used by I. G. Farbenindustrie in Germany which comprises (1) extracting rock phosphate with a mixture of nitric and phosphoric acids using sufficient phosphoric acid so that the mole ratio of CaO/P_2O_5 in the extract is 2.0 or less, (2) ammoniating the extract to form dicalcium phosphate, ammonium nitrate, and ammonium phosphate; (3) adding muriate of potash; and (4) drying to produce a three-component fertilizer called "Nitrophoska." A typical Nitrophoska grade is 12-12-21.[1] (The name Nitrophoska has also been applied to fertilizers made by other processes.)

3. A process used in France by the Societe Potasse et Engrais Chimiques (PEC) which consists in (1) extracting rock phosphate with nitric and sulphuric acids using sufficient sulphuric acid so that the mole ratio of CaO (excluding calcium sulphate) to P_2O_5 in the extract is about 2.0; (2) ammoniating the extract to form a slurry containing dicalcium phosphate, ammonium nitrate, and calcium sulphate; (3) adding muriate of potash; and (4) drying to produce a three-component fertilizer. A typical formula of the fertilizer made by the PEC process is 10-10-20*.

Although the processes described have been used commercially, further development work was deemed necessary by TVA because very little detailed information was available with regard to methods and equipment, and it appeared likely that improvements could be made. Furthermore, there was very little information on the suitability of types of rock phosphate available in this country.

After review of the available information, four processes were selected as most promising technically and economically for further development. The process used by the Odda Smeltwerke and Netherlands State Mines was not studied experimentally because it was felt that the marketability of the calcium nitrate byproduct in this country was doubtful. Another drawback was that the separation of the calcium nitrate appeared to be complex and expensive.

ACIDULATION

The acidulation steps of the four processes are similar and consist of decomposing rock phosphate with nitric acid or mixed acid. The principal chemical reactions and suitable proportions of acid to rock phosphate are indicated by Eqs. (1), (3), (5).

In these equations, rock phosphate is represented by

* Following the usual fertilizer practice, fertilizer grades given in this paper indicate the percentages of nitrogen (N), available phosphoric acid (P_2O_5), and potash (K_2O), by the first, second, and third numerals respectively.

the chemical formula $Ca_{10}F_2(PO_4)_6$, which is that of fluorapatite. Actually, rock phosphate usually contains calcium compounds other than fluorapatite, as well as other impurities. In the present work, the acid used for decomposing rock phosphate was proportioned on the basis of the total CaO shown by analysis of the rock. For example, when nitric acid alone was used for acidulation as in Eq. (5) a ratio which provided 2 moles of HNO_3 for each mole of CaO in the rock was termed stoichiometric. Smaller proportions of nitric acid would be sufficient to decompose rock phosphate with formation of monocalcium phosphate as illustrated by

$$Ca_{10}F_2(PO_4)_6 + 14HNO_3 \longrightarrow 3Ca(H_2PO_4)_2 + 7Ca(NO_3)_2 + 2HF \qquad (1a)$$

It was found that rock phosphate could be decomposed with the proportion of nitric acid indicated by Eq. (1a); as much as 98 percent of the P_2O_5 was made citrate soluble by this acidulation. However, conditions were not found that would permit ammoniation of the acidulated rock without serious loss of citrate solubility. The higher proportions of acid shown by Eqs. (1), (3) and (5) represent approximately minimum ratios of acids to calcium oxide content of rock phosphate that yielded ammoniated products of consistently high P_2O_5 availability under conditions described.

In Process I, Eq. (1), the proportion of phosphoric acid used is such that the acidulate contains 2 moles of CaO per mole of total P_2O_5 (including P_2O_5 from both rock phosphate and phosphoric acid). Result is that all the calcium will be precipitated as dicalcium phosphate in the subsequent ammoniation step except for a small proportion that forms calcium fluoride. Likewise, in Process II, Eq. (3), the proportion of sulphuric acid used is such that the formation of $CaSO_4$ leaves 2 moles of CaO per mole of P_2O_5.

Use of an excess of phosphoric or sulphuric acid over that indicated by Eqs. (1) and (3) leads to conversion of increased proportions of the P_2O_5 to ammonium phosphate in the subsequent ammoniation step, which may be desirable for fertilizer usages in which the presence of substantial proportions of the P_2O_5 in a water-soluble form is important.

Because it is believed that such a form may be highly desirable, greenhouse and field experiments are underway at the present time. Investigators are testing this water soluble form by varying soil and crop conditions, observing carefully the results.

AMMONIATION

The reactions that occur during the ammoniation step are represented by Eqs. (2), (4), and (6).

The ammoniation step was carried out in a pilot plant and in smaller-scale equipment using agitator tanks equipped with high-speed propeller-type agitators or slower-speed gas-absorption-type turboagitators. Ammonia was supplied in gaseous form through an open-end pipe that discharged close to the agitator. It was found convenient to use the pH of the solution as a criterion for controlling the proportion of ammonia; ammoniation to a terminal pH of about 4.5 was suitable in most cases.

It was essential that the slurry remain in a fluid condition and that vigorous agitation be provided during the ammoniation step. Failure to provide those conditions often resulted in precipitation of a portion of the phosphate in a citrate-insoluble form. The chemical composition of the citrate-insoluble precipitate was approximately that of fluorapatite, and its x-ray diffraction pattern was that of an apatite.

PRODUCT COMPOSITIONS

Process I—A series of products were prepared by Process I in which varying proportions of phosphoric and nitric acid were used with resultant variation in the proportion of water-soluble P_2O_5 in the ammoniated products.

Typical analyses of the dried, ammoniated products follow (Figures given are composition, percent):

Mole Ratio H_3PO_4/HNO_3	1:4	1:2	1:1
Grade	17-22-0	14-28-0	12-35-0
N	17.5	14.2	12.1
P_2O_5, Total	22.2	28.6	35.6
Available	21.9	28.6	35.4
Water soluble	1.6	8.8	16.5
CaO	17.1	17.5	16.7
Moisture	1.8	0.5	0.7

Because there is relatively little demand for direct use of a fertilizer material containing only nitrogen and phosphate in the major fertilizer-consuming areas of the eastern U. S., potash was added to the products described above. It appeared that there would be an advantage in adding the potash to the fluid materials during processing to afford a homogeneous mixture that would preclude segregation of its ingredients, which may occur with dry mixed fertilizers. Also, the expense of a separate handling and mixing step could be avoided.

Typical grades of products containing potash were 15-18-10, 11-22-11, 10-20-16, and 14-14-14. The plant-food contents of these products are more than twice those of widely used commercial mixed fertilizers that have similar proportions of plant-food ingredients (such as 6-8-4, 5-10-5, and 4-10-7).

Since these products contain ammonium nitrate, they are hygroscopic, and when exposed to humid atmosphere they eventually become wet and muddy. The use of bags containing at least one moisture-proof ply (such as asphalt-laminated paper) was necessary to prevent excessive moisture absorption in storage. However, tests showed that the products were notably superior to conditioned, grained ammonium nitrate both in absence of caking in bag-storage tests and in drillability after exposure to humid atmosphere.

Process II—Although this process, the sulphuric acid process, can be adapted to production of fertilizers of various proportions of nitrogen, phosphate, and potash, pilot-plant studies of this process have been restricted to production of an 11-11-11 product except for a small lot of 11-14-0. A product containing approximately equal proportions of N, P_2O_5, and K_2O was selected for pilot-plant study because it appeared that such a material would fill many of the fertilizer needs of the eastern U. S.

Typical analyses of the pilot-plant products follow:

Grade	11-11-11	11-14-0
N	11.1	11.3
P_2O_5, Total	11.7	14.6
Available	11.3	14.0
Water soluble	1.8	5.0
K_2O	11.7	——
CaO	10.6	20.7
SO_3	9.5	18.6

The hygroscopicity of these products was similar to that of Process I materials, but they retained satisfactory physical properties somewhat longer on exposure to humid atmosphere.

Process III—When the ammoniated slurry of the composition indicated by Eq. (6) was dried without potash addition and the dried product was cooled, crushed, and sized, a free-flowing, dry-appearing product was obtained. The product, because of its calcium nitrate content, absorbed moisture very rapidly when exposed to humid atmosphere and soon became sticky and eventually reached a consistency of thin mud. It was found that the

hygroscopicity of the dried product was greatly decreased when potassium sulphate was added to the ammoniated slurry in proportions equal to or greater than that required to react with the calcium nitrate content of the slurry according to the following equation:

$$Ca(NO_3)_2 + K_2SO_4 \rightarrow CaSO_4 + 2KNO_3 \qquad (6b)$$

Typical analyses of products obtained with and without sulphate of potash follow:

	Without K_2SO_4	With K_2SO_4
Grade	16-15-0	12-11-11
N	16.7	12.1
P_2O_5, Total	15.3	11.1
Available	14.9	11.0
Water soluble	1.5	0.4
K_2O	—	11.4
CaO	22.3	16.8
SO_3	—	9.7

The hygroscopicity of the 12-11-11 product was similar to that of Process II materials and was deemed satisfactorily low for fertilizer usage.

Process IV—Slurry of the composition indicated by Eq. 8 contains in the solid phase precipitated dicalcium phosphate, calcium fluoride, iron and aluminum phosphate, and silica. The solid may be removed by filtration and washing; the filtration rate was sufficiently high to indicate industrial feasibility. Following is a typical analysis of impure dicalcium phosphate obtained from Tennessee brown rock (31 percent) P_2O_5 by this process.

P_2O_5, Total	35.6
Available	34.2
CaO	36.3
Al_2O_3	2.5
Fe_2O_3	3.8
F	2.8
SiO_2	12.9
Moisture	4.1

When precipitation of dicalcium phosphate by ammoniation was carried out in two steps with intervening filtration, the first precipitate contained 25 percent of the P_2O_5 together with most of the impurities and the second precipitate contained 75 percent of the P_2O_5 in the form of nearly pure dicalcium phosphate. Analyses of the two precipitates follow:

	First step	Second step
P_2O_5, Total	24.6	49.1
Available	23.2	48.7
CaO	13.6	39.4
Al_2O_3	7.0	0.2
Fe_2O_3	10.0	0.4
F	7.8	0.3
SiO_2	20.0	—

Thus it was shown that it would be feasible to recover a part of the dicalcium phosphate in a nearly pure form that might be suitable for use as an animal-feed supplement and the remainder in a form suitable for fertilizer use.

The filtrate from the dicalcium phosphate separation step consisted of a solution of calcium nitrate and ammonium nitrate with small percentages of P_2O_5. By treating this solution with carbon dioxide and ammonia, the calcium carbonate was precipitated and all the nitrate was converted to ammonium nitrate by the following reaction:

$$Ca(NO_3)_2 + CO_2 + 2NH_3 + H_2O \rightarrow 2NH_4NO_3 + CaCO_3 \qquad (8c)$$

The ammonium nitrate solution from this step was of sufficient purity for production of ammonium nitrate by evaporation and graining or crystallizing.

It has been suggested that the ammonium nitrate solution containing calcium carbonate be evaporated and grained without separation, since the presence of calcium carbonate might improve the physical properties and stability of the ammonium nitrate. It would be necessary to carry out the latter stages of evaporation and graining at a lower temperature than that normally used to preclude serious loss of ammonia which occurs when calcium carbonate and ammonium nitrate are brought together at high temperature.

ACKNOWLEDGMENT

The author wishes to acknowledge the able assistance of E. C. Houston, L. D. Yates, M. M. Striplin, Jr., R. E. Dunn, J. L. Graham, F. T. Nielson, D. McKnight, and many others in carrying out the experimental work, and of J. Silverberg in the preparation of the report.

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European Progress in Nitric Acidulation of Rock Phosphate

M. H. R. J. PLUSJE

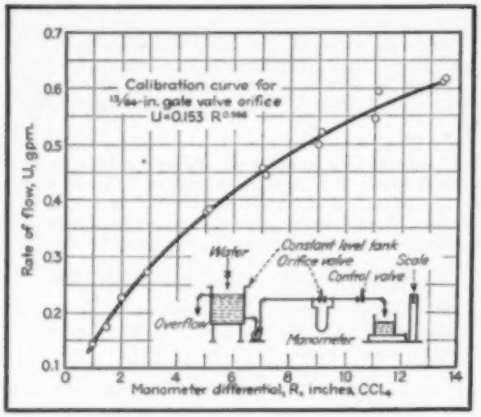
Recent developments in the Netherlands State Mines process are important because sulphur shortages mean ammonium sulphate shortages.

At the Netherlands State Mines they have found that in the nitric acid treatment of rock phosphate it is possible to operate so that subsequent neutralization of the acidified material would give directly a desired mixture of ammonium nitrate and dicalcium phosphate. They have been standardizing on the production of a mixture of 60 parts of ammonium nitrate with 40 parts of dicalcium phosphate, this mixture containing 20.5 percent of N and 20 percent of citrate-soluble P_2O_5.

In the method used, now in the advanced development stage, the phosphate rock is dissolved in nitric acid of about 50 percent concentration, the reaction leading to the production of calcium nitrate, orthophosphoric acid and water. Part of the calcium nitrate is removed—as calcium nitrate-hydrate—by crystallization after cooling the solution. The process is so adjusted that the mother liquor contains equimolecular amounts of calcium nitrate and orthophosphoric acid. This mother liquor is neutralized with ammonia, careful control of the pH being necessary to make sure that the end product contains no calcium nitrate which would render the final product very hygroscopic. After neutralization, the mixture is concentrated, granulated, dried and cooled in the usual manner.

For the production of a phosphatic fertilizer consisting essentially of a monocalcium phosphate, the State Mines have worked out a cyclic process in which, after the acidification of the phosphate rock with nitric acid, the solid monocalcium phosphate is separated. To the filtrate there is added more nitric acid and, after cooling, calcium nitrate-hydrate is crystallized out and removed. The temperature of the mother liquor from this stage is then raised and the cycle repeated.

From a paper presented before the Fertilizer Society, London, England, Feb. 16, 1951.



Use an Orifice-Valve for Checking Flow Rates Periodically

J. B. O'Hara,* *School of Mines and Metallurgy, University of Missouri, Rolla, Mo.*

★ **March Contest Prize Winner**

One of the disadvantages of using an orifice for measuring fluid flow rates is the resulting pressure drop and consequent power consumption. This is especially true in cases where the flow needs to be kept within reasonable limits over long periods of time, but does not have to be kept exactly constant. When this is the situation, a large part of the power loss caused by the orifice can be saved by using a removable orifice which is inserted in the line only at the time when the flow rate is to be checked. Typical of processes where an occasional check of the flow rate is satisfactory might be stack scrubbers, or processes in which solid particles of non-uniform size are washed by an upward flow of water to remove soluble material. Without the occasional check of these relatively non-critical flows, satisfactory operation would be unlikely.

It is true that there are other flow-measuring instruments such as venturis, flow nozzles and rotameters which would result is less power loss, but sometimes their expense may not be justified. The idea of a removable orifice itself is not new and there are in fact such orifices and accompanying fittings on the market. Again the expense might not be justified. A simple substitute for the conventional removable orifice can be made easily by drilling a concentric hole through the gate of a wedge-disk gate valve. It is true that such an orifice will not correspond to one in thin plate, but it will give satisfactory results by calibration if the burrs resulting from drilling are removed.

In the case discussed here a 11-in. hole was drilled in the disk of a ¼-in. valve gate, after which it was calibrated by weighing with the set-up diagrammed on the calibration curve. A constant-level tank supplied water to a small centrifugal pump. Water from the pump discharged through a line containing the orifice-valve and a control valve, to a weigh tank on a platform scale. A manometer is connected around the orifice-valve.

The calibration procedure consisted in: (1) adjusting the control valve to an approximate desired flow rate; (2) with the orifice-valve open, measuring the flow rate by weight against time; and (3) measuring the pressure differential with the orifice inserted in the line. Although the flow decreases when the orifice-valve is closed momentarily, it is still possible to use the differential so obtained as a measure of the flow rate which maintained before the orifice was inserted in the line. This is shown by the reproducibility of readings indicated on the chart, and by the tabulation of results.

A plot of the data on log-log paper indicates that the calibration equation is of the form $U = KR^n$ where U is flow rate in gpm., K and n are constants, and R is the manometer differential. In this case the manometer liquid was CCl_4 and the constants were found to be $K = 0.153$ and $n = 0.568$.

The chart shows that consistent results can be obtained, while the table shows a maximum deviation from the mean curve of 5.7 percent, with an average deviation of 1.8 percent. The Reynolds numbers show that operation occurred in both streamline and turbulent regions. Hence it seems that such a removable orifice can be used safely for periodic flow-rate checks in applications where a momentary change in flow rate during measurement can be tolerated. A conservative estimate of the accuracy obtainable is ±5 percent, although most measurements should be within ±3 percent.

The author acknowledges gratefully the work of

* Present address: Lehigh University, Bethlehem, Pa.

★**April Contest Prize Winner**

"How to Save Time in Calculating Pipe Sizes and Flow Velocities."

A prize of $50 in cash will be awarded to Frank Lerman, Director of VioBin Corp.'s Bio-Engineering Division, Monticello, Ill. The prize winning entry will appear in the June issue.

$50 PRIZE FOR A GOOD IDEA—Until further notice the Editors of *Chemical Engineering* will award $50 cash each month to the author of the best short article received that month and accepted for publication in the Plant Notebook.

The winner each month will be announced in the issue of the next month, e.g., the May winner will be announced in June and his article published in July. Judges will be the editors of *Chemical Engineering*. Non-winning articles submitted for this contest will be published if acceptable at space rates.

HOW TO ENTER CONTEST—Any reader of *Chemical Engineering*, other than a McGraw-Hill employee, may submit as many entries for this contest as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible.

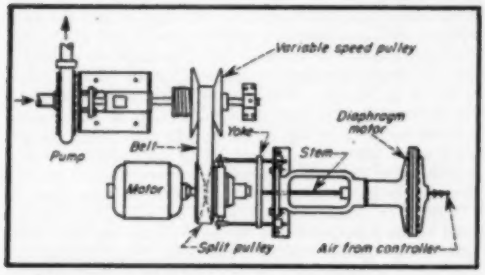
Articles may deal with any sort of plant or production "kink" or short-cut that will be of interest to chemical engineers or others in the process industries. Also, novel means of presenting useful data are acceptable. Address Plant Notebook Editor, *Chemical Engineering*, 330 West 42nd St., New York 18, N. Y.

Messrs. H. C. Iten, W. A. Chapuk, D. H. MacDonald and E. E. Slover, former students at the University of Missouri School of Mines and Metallurgy, in developing the idea and obtaining the data.

Calibration Data for 13/64-In. Gate-Valve Orifice

Differential, In. CCl_4	Rate of Flow, Gpm.	Reynolds No. Based on Pipe Diam	Reynolds No. Based on Orifice Diam.	Deviation From Mean, Percent
13.50	0.618	2,880	8,870	+0.8
13.40	0.612	2,845	8,770	0.0
11.10	0.595	2,770	8,540	+5.7
11.00	0.542	2,520	7,770	−3.7
9.10	0.522	2,430	7,480	+0.8
9.00	0.498	2,320	7,150	−3.0
7.10	0.445	2,075	6,380	−2.4
7.00	0.456	2,125	6,550	+1.1
5.10	0.385	1,791	5,520	+0.5
5.00	0.378	1,760	5,420	0.0
2.90	0.272	1,268	3,900	−0.7
2.00	0.227	1,058	3,260	+3.2
1.45	0.174	810	2,490	−3.3
1.00	0.144	670	2,060	0.0

Avg. deviation 1.8



Applying Automatic Control to Pumping Speed

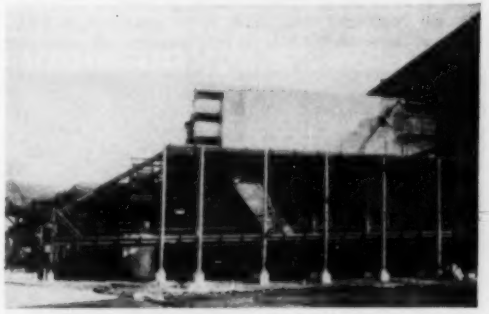
J. M. Crockin, *Blaw-Knox Division, Pittsburgh, Pa.*

Illustrated here is an assembly that has proved valuable in controlling the pumping rate of fluids in response to the demands of a pneumatically operated float controller. It operates by controlling the pump speed. One such application has been in the pumping of slurries with a centrifugal pump, where throttling of the discharge was not practical; another, the pumping of a volatile liquid with a rotary pump, where the use of bypass control was found undesirable. It is apparent that the assembly can be used in conjunction with an air-operated flow controller, pressure controller, or any similar fluid-operated controller.

This assembly has been in continuous service for over a year, and has been found to be quite sensitive. It is as free from difficulties such as lag or hunting as more conventional air-operated instrument applications.

The pump or other driven device is provided with an outboard bearing for the extended shaft. The shaft carries a variable pitch pulley, whose halves spread or close against the tension of a spring, thus exerting tension on the belt. Control is obtained by using the top-work from a pneumatic control valve (i.e., a diaphragm motor) which responds to variations in air pressure from a level controller, a flow controller, etc. A change in air pressure from the controller pilot alters the position of the stem. As the stem moves, it moves the yoke which spreads or closes half of the split pulley. Hence the belt assumes a corresponding position on the cone face of the pulley. Since the two pulleys are on fixed centers, a change in the effective pitch diameter of the drive pulley brings about a corresponding change in the pitch diameter of the variable pitch driven pulley.

The changes in the pitch diameters of the pulleys change the speed of the pump, so that pump speed becomes a function of the level or flow-controller demand. Each position of the controller, thus calls for a definite and reproducible pump speed.



Insulating Equipment While Hot Prevents Expansion Cracks

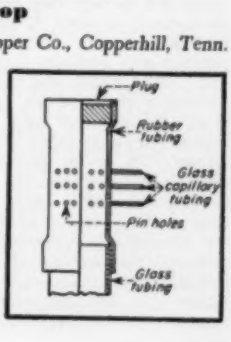
Engineers of the Disco Corp., at Imperial, Pa., solved the problem of expansion cracks in the insulation covering their high-temperature carbonizers and roasters by applying the insulation at operating temperature. This low-temperature carbonization process for coal (Chem. Eng., June 1949, p. 112) employs seven carbonizers each 125 ft. long and 9 ft. in diameter, and an equal number of roasters, 6 x 16 x 95 ft., in processing over 1,000 tons of coal per hr. to produce tar, gases and a smokeless fuel. Carbonizer temperatures range from 1,050 to 900 deg. F., and roaster temperatures from 900 to 600 deg. F. Thermal expansion from shutdown to process temperature adds about 8 in. to the length of each carbonizer, and 5 in. to each roaster, which means that if the insulation had been applied while cold, cracking would have been likely.

The insulation, consisting of 24 x 48-in. mineral wool blankets between metal lath and wire netting, is secured to the hot surfaces by impaling on studs welded to the equipment shells on 9-in. centers. The job required 300,000 such studs. The roasters were covered with 4-in. blankets, and the carbonizers with two such thicknesses. A weatherproof finish consisting of ¼ in. of insulating cement, 1-in. mesh wire, and an asphalt mastic finished the job.

Producing Uniform Gas Bubbles At Low Pressure Drop

Li Wen Han, *Tennessee Copper Co., Copperhill, Tenn.*

Sketched at the right is a simple way to construct a bubbler for laboratory and pilot plant use which will disperse uniform small gas bubbles in a liquid with negligible pressure drop.



A piece of rubber tubing is slipped over the end of a glass tube and its other end is plugged with a piece of glass rod or rubber stopper. A number of pinholes,

the number depending on the quantity of bubbles desired, is punched in the rubber tubing. Then a uniform glass capillary tube is drawn by ordinary techniques, with its diameter dependent on the size of bubbles desired. The capillary is then cut into short lengths, about ¼ in. long or a little less, and these are inserted in the pin holes so as to act as uniform discharge nozzles. The bubbler has been used successfully in an experimental tower where it dispersed wet SO_2 gas into corrosive salt solutions.

Plan Now for Conservation of Industrial Rubber Goods

F. P. Murkin and W. H. Van Buren, *Quaker Rubber Corp., Philadelphia, Pa.*

Now that the United States is again involved in defense preparations, with even greater demands on the industrial machine than in World War II, process industries and other industrial rubber goods users must conserve their equipment as best they can, and reduce the burden of maintenance as much as possible so as to free manpower for other purposes. Current rubber shortages for civilian purposes give particular point to this admonition.

To advance this idea the authors' company has been advocating the adoption of "conservation maintenance plans" by industrial users of rubber products and has been offering suggestions to users which can result in large savings. One of the best ways to put such a plan into effect is for each concern to appoint an engineer, particularly one who is young, responsible and energetic, to have complete charge of the conservation effort, and to report direct to a high company official, such as the works manager. This engineer should list all equipment, make frequent inspections—daily if possible—and record his observations and suggestions for needed maintenance, changes and improvements. Rubber industry engineers will be only too glad to help "break him in" on his new job, as well as to provide him with detailed information on best practices in rubber use.

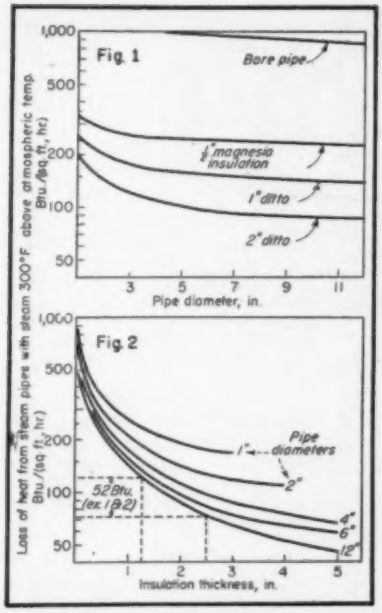
As an example of what can thus be uncovered, one of the authors made a trip around a pigments plant with a company engineer designated for this conservation job. Considering only belt conveyors, some of the things that were discovered included: (1) A power plant coal conveyor was too narrow for its job and had a skirt board the entire length which was wearing the belt badly. Doubling the belt speed made high loading unnecessary but a wider, more flexible belt would have been better and would be ordered when replacement became necessary. (2)A belt handling pigments in oil was found to have a badly deteriorated natural rubber cover. Decision was to allow the belt to run until failure if investigation showed that rubber particles would not harm the pigment, then replace it with a neoprene-covered belt. (3) A belt carrying oxides from a kiln to storage at 400 deg. F. was found to be failing in from one day to two weeks. The feed chute was redesigned to cool to 300 deg. F. and the belt replaced with one having a neoprene cover and fiber glass reinforcement in the carcass. (4) The main car unloader belt was being damaged by large lumps of abrasive ores, up to 14 in. in size. The loading chute was changed to put material on the belt in the direction of belt travel, and was provided at the discharge end with a bar grizzly, tilted up at the end to deflect lumps up slightly and not directly on to the belt. The grizzly allowed fines to form a layer on the belt below the lumps, and so cushion them.

A series of inspection trips by the second author showed some of the difficulties that chemical plants can have with rubber hose. In one case hose was being dragged across the floor some 35 times each 24 hr. The tube showed little or no damage but the cover was considerably worn. This in time would expose the fabric to quick deterioration from splashed acid. The recommendation was to apply rubber cement to the worn spots and then to cement a ½-in. square rubber strip spirally on to the outside of the hose. An alternate scheme would be to slip ½- or ¾-in. ring gaskets about ¼ in. smaller in diameter than the hose over the hose at 1-ft. intervals.

A common hose problem in chemical plants is how to make a hose rigid without putting in a permanent reinforcement. The easiest and cheapest method seems to be to run a piece of wire cable between the two connections and attach the hose to it with wire bands or clamps. A cable size of ½ or 1 in., depending on hose size, is suitable.

Most hose made for outdoor and abrasive service is compounded to resist sun and cracking, but it should still be drained before storing and then coiled down in a cool, shady place. A neoprene cover helps in such service to avoid weather cracks and consequent fabric exposure.

There are a number of important do's and don'ts that will help to get the maximum possible service out of the hose you have. (1) Never kink a hose to retard the flow. This weakens the structure and eventually produces a break. (2) Don't expose a hose to oil and grease. If you must, scrub it clean with plain water or a mild alkali. (3) When a hose is to be connected overhead, see that the connection points down. Top connection causes a sharp bend and shortens the life. (4) Don't hang a hose from hooks or boards, since this produces a concentrated strain. Draining and coiling down is still the best storage method. (5) When a hose must be laid across a traffic path, protect it with boards higher than the hose diameter. (5) Never pull a hose around sharp corners and don't strain it at the fitting to make it reach. (6) Don't leave a hose under pressure when not in use. (7) Finally, insist on care in coupling and don't forget the need for regular inspections.



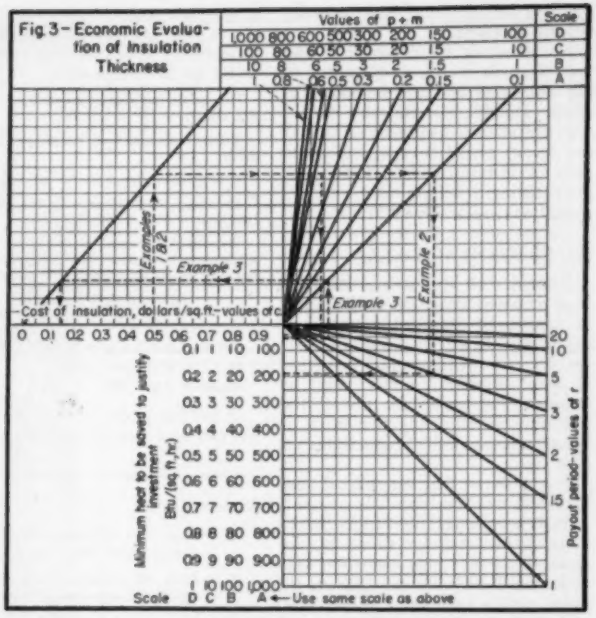


Fig. 3 – Economic Evaluation of Insulation Thickness
Values of p ÷ m
Scale
Example 1
Example 2
Example 3
Cost of insulation, dollars/sq. ft. – values of c
Minimum heat to be saved to justify investment Btu./(sq. ft., hr.)
Payout period – values of r
Scale D C B A ← Use same scale as above

EXPERIMENTAL HEAT LOSS DATA such as shown in Figs. 1 & 2 are used in conjunction with Fig. 3. If the minimum heat which must be saved to warrant investment in a given amount of insulation (from Fig. 3) is greater than the amount of heat which actually can be saved by this insulation, the investment cannot be justified. Calculated heat losses often give rise to serious errors.

Before You Insulate—

Take into account these factors:

Boiler Capacity—Sometimes we have to decide between spending for insulation and spending to increase boiler capacity.

Payout Period—Your decision to insulate cannot be sound without it.

Experimental Heat Loss Data—Calculated losses are often way off.

S. R. STEINBOCK

The decision of whether or not to invest in insulation can be made more confidently if certain factors, often ignored, are taken into account. Before showing how these factors may be applied to the solution of typical problem, here is why each is important:

BOILER CAPACITY

The problem of whether to apply thermal insulation does not always involve fuel savings alone.

For example, where fuel is very cheap or presents a disposal problem (as waste gas in a petroleum refinery), insulation could hardly be justified on the basis of fuel savings. In such cases the purpose of insulating steam lines, for example, would be to permit the use of a smaller steam generating plant. Here we have a choice between investing in boiler capacity and investing in insulation.

PAYOUT PERIOD

Strange as it may seem, the payout period (ratio of investment to annual savings) is sometimes ignored in deciding whether or not to insulate. The decision cannot be sound without it.

The policy with respect to payout period varies from company to company. In the case of thermal insulation the investment must be kept below the payout period multiplied by the anticipated annual savings, both in fuel costs and capital expenditure

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(such as the additional boiler capacity referred to above.)

No allowance for depreciation and taxes is made in the development of the equations and in the examples which follow. No difficulty should arise out of such treatment so long as the payout period is expressed as the ratio of investment in insulation to gross savings (before taxes and depreciation).

EXPERIMENTAL DATA

Estimates of heat savings resulting from proposed insulation can be made, of course, by standard methods of calculation based on assumed heat transfer rates. Unless good judgment is used, however, errors may be serious. One reason for this is the difficulty of estimating the effect of various geometrical configurations on heat loss.

Fig. 1 shows that geometrical configuration must be taken into account. Actual heat losses for various thicknesses of insulation are shown to vary considerably with pipe diameter. This is because heat losses are different for a flat surface than for a curved one, and the larger the pipe the nearer it comes to being a flat surface.

Often experimental data such as that given in Figs. 1 and 2 can be found. The use of such data is much more likely to give good results, and these types of data are available to a far greater extent than generally realized.

In cases where experimental data are not available, special research projects may have to be undertaken to get them. Naturally, where only minor investment is being considered, there would hardly be any justification for this. But where investment is likely to be appreciable, the importance of accurate physical data cannot be exaggerated.

THESE FACTORS APPLIED

We are now ready to develop a method for determining if a given amount of insulation can be justified. We will take into account boiler capacity and payout period in developing the method, and use experimental rather than calculated data in the examples which illustrate the use of this method.

Consider a system in which more heat is required. This heat can be supplied either by insulating or increasing boiler capacity. We will assume insulating with a given thickness of insulation is the course to take, and then prove whether or not this is the right course. (Where boiler capacity is adequate to meet the anticipated rise in heat requirements, investment in increased boiler capacity of course would not be considered.)

Heat saved per year by insulating $= 8{,}760\ HA$ dollars.

Value of this heat $= 8{,}760\ HAp/1{,}000{,}000$ dollars (1)

Investment in insulation $= cA$ dollars (2)

Investment in boiler capacity for equivalent heat $= HAq/1{,}000{,}000$ dollars (3)

For the investment in insulation to be attractive, the ratio (2)—(3)/(1) must be equal to or less than the payout period r:

$$\frac{cA - (HAq/1{,}000{,}000)}{8{,}760\ HAp/1{,}000{,}000} \leq r$$

Hence $H \geq 114\ c/(p + q/8{,}760\ r)\ r$

or $H \geq 114\ c/(p + m)\ r$ (4)

where $m = q/8{,}760\ r$

A prompt graphical solution to Eq. (4) can be obtained from Fig. 3, and the following examples will illustrate the manner in which the analysis can be accomplished.

NOMENCLATURE

- H = Heat that will be saved if insulation is added, Btu./(sq. ft., hr.)
- A = Area of exposed surface before addition if any insulation, sq. ft.
- c = Cost of proposed insulation, $/sq. ft.
- p = Value of heat, $/million Btu.
- q = Boiler or furnace investment that would have to be made if no insulation were added, $/(million Btu., hr.)
- r = Payout period (required investment/annual savings), years.

Example 1—Application of additional magnesia insulation 1¼ in. thick to a 12-in. steam line would cost 50 c. per sq. ft. The steam to air temperature is 300 deg. F. and the line already has a magnesia insulation cover 1¼ in. thick. Boiler capacity is already limited, and unless heat losses are reduced additional boiler capacity will have to be installed, and the cost of such an installation is estimated at $9 per thousand Btu. per hr., to cover the cost of the boiler plant, auxiliaries, feedwater treatment, etc. Fuel costs 8 c. per million Btu. and boiler efficiency is 80 percent. The required payout is 3 yr. (Such conditions may well exist in foreign oil fields and chemical plants, where fuel is cheap, equipment costs high and a short payout period is required due to the high royalties paid to foreign rulers, heavy risks due to political uncertainties, etc.) Would the proposed investment in insulation be economically justified?

$c = 0.5$

$r = 3$

$p = 0.08/0.80 = 0.1$

$q = 9 \times 1{,}000 = 9{,}000$

$p + m = 0.1 + 0.344 = 0.444$

$m = 9{,}000/(8{,}760 \times 3) = 0.344$

From $c = 0.5$ on Fig 3, draw a vertical line to meet the inclined curve $p + m = 0.444$, and down to curve corresponding to $r = 3$. Proceeding now to the left we find 43 as the minimum Btu./sq. ft./hr. which must be saved in order to justify the contemplated investment in the insulation.

We must now check from physical data whether this would be accomplished. By reference to Fig. 2 we find that the actual heat saved would be approx. 52 Btu./sq. ft./hr. The condition is therefore satisfied and hence the investment is warranted.

Example 2—Conditions are the same as in Example 1, but boiler capacity is adequate and no additional investment would be required in this direction.

As before:

$c = 0.5$

$r = 3$

$p = 0.1$

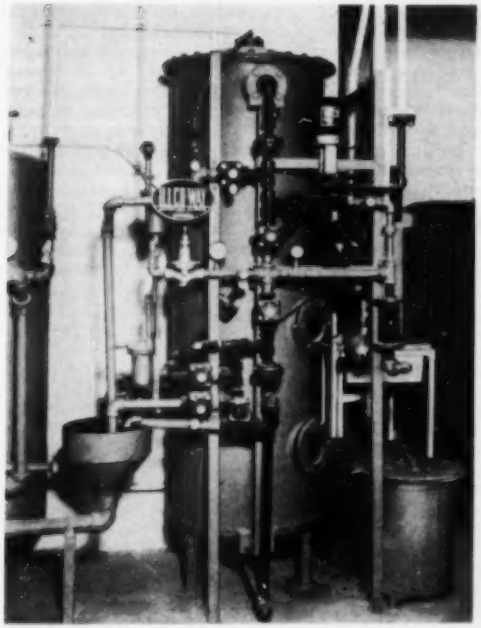
But: $q = 0$

hence $p + m = 0.1$

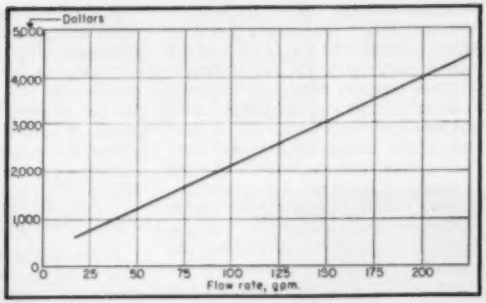
Starting as before from $c = 0.5$ on Fig. 3 we proceed vertically up and then horizontally to curve $p + m = 0.1$. Thence vertically down to $r = 3$ and then to the left. The minimum heat which must be saved appears as 190 Btu./sq. ft./hr., and from Fig. 2 we find that this would not be accomplished. Hence the investment in this case cannot be economically justified.

Example 3—With the problem identical to the case in Example 2, find the economic price of proposed insulation.

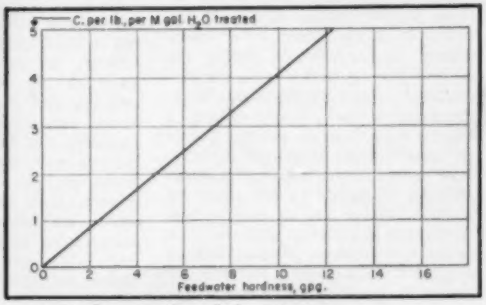
From Fig. 2 we find that the heat which can be saved in this case is approx. 52 Btu./(sq. ft., hr.). Starting from 52 on the scale of heat saved (Fig. 3) proceed horizontally to curve $r = 3$ and then vertically up to curve $p + m = 0.1$. Then draw a horizontal line to the inclined curve in the first quadrant and proceed vertically down, to find $c = 0.14$. Hence, if the additional insulation could be applied for 14 c. per sq. ft. the investment would be justified.



This mixed-bed deionizer cuts . . .



. . . cost of pretreatment equipment and . . .



. . . cost of regenerating salt in pretreater.

How to Cut Costs in Deionization

F. H. KAHLER and W. S. MORRISON

Presoftening is expensive. Proper design of mixed-bed deionizers keeps this cost down.

Can you save money with mixed-bed dionization? Here are some facts that show how maximum mixed-bed deionization can be accomplished while cutting down expensive pretreatment of feedwater.

In any deionizing system there are problems of possible precipitation in the exchange beds. However, they can be overcome. A simultaneous system of regeneration in which the caustic soda regenerant is added to the anion exchange material while an acid solution is added to the cation exchange material does the job. In this method both spent regenerant solutions are discharged through an outlet at the interface of the resins. This eliminates contact of either resin with the regenerant of the other exchange material. It also eliminates any possibility of precipitation in the resin bed between caustic soda and magnesium ion from the cation material. It avoids complete exhaustion of either exchanger.

Why not run caustic soda through both beds in the regenerating cycle? Cation exchange materials are regenerated with an alkaline solution; newer and strongly basic materials require caustic. Caustic soda must be made up and if ejected, drawn into the reactor with water free of magnesium to prevent the precipitation of magnesium hydroxide in the exchange bed. The solubility product of magnesium hydroxide at 18 deg. C. is 1.2×10^{-11}.

A molar magnesium ion concentration of 1.11×10^{-11} (equivalent to 2.67×10^{-7} ppm.) will result in precipitation of magnesium hydroxide. Obviously any detectable magnesium in the raw water will cause precipitation in a 5 percent caustic solution. Any precipitate will dissolve slowly in the acidic cation exchange water, giving a final effluent that is poor in quality. To provide magnesium-free water for regeneration of the anion exchangers, it is customary to provide a water softener with deionizing equipment or in two-bed systems to add sufficient capacity to the cation exchanger to furnish the required water. These problems of possible precipitation in exchange beds are present whether the equipment is the conventional two-bed type or the mixed bed type. They can be quite readily overcome and present no greater problem in mixed bed operation than in the more common two-bed system.

In discussing mixed bed deionization, Reents and Kahler* outlined six methods of regeneration. It was indicated that all of these would give comparable quality of effluent water. Further experimentation and field data show distinct advantages in certain of these methods. Two of the methods suggested using a caustic

F. H. KAHLER and W. S. MORRISON are water treatment engineers with Illinois Water Treatment Co. at Rockford, Ill.

solution through the entire bed as the first step. The caustic solution then contacts both the anion and the cation exchangers. When a caustic solution contacts the cation exchange material which is exhausted with calcium and magnesium, the sodium ion of the caustic solution will elute the calcium and magnesium. In the presence of relatively high concentration of alkali, magnesium hydroxide will immediately precipitate. This precipitation will occur throughout the resin bed and in the interstices of the resin particles. Later regeneration of the cation exchange material with acid will not completely dissolve and remove this precipitate. As a result, the cation exchange material is inefficiently regenerated and during the entire following service cycle, the precipitated magnesium hydroxide tends to dissolve very slowly—giving a treated water poor in quality. Use of the simultaneous system of regeneration in which the caustic regenerant solution is applied to the anion exchange material and an acid solution to the cation exchange material eliminates this problem. Another method suggested in eliminating the difficulty caused by precipitation of magnesium hydroxide when caustic is applied to the entire bed requires that the entire water supply be softened prior to treatment with a mixed bed deionizer.

KEEPING COSTS DOWN

Pretreatment with a sodium exchanger will eliminate the precipitation problem. But it requires considerable additional equipment investment to provide the softening capacity. It also means an increase in operating costs for chemicals. Sodium exchange does not decrease the dissolved solids content of the water supply and consequently the increase in chemical costs will be that required to pre-soften the water. In the accompanying graph the approximate initial cost for sodium exchange equipment as a function of the flow rate required is shown. For example, if deionized water is to be produced at a flow rate of 100 gpm. the sodium exchange equipment required to pretreat the water will add approximately $2,200 to the total equipment cost. In the second accompanying chart the cost per thousand gallons of salt required to generate the sodium exchange equipment is shown. In this graph the cost is shown as a function of the hardness in the raw water supply. If a raw water contains 10 grains per gal. hardness, sodium exchange will add about 4c. per M gal. to the cost of the chemicals required.

The simultaneous system of regeneration does not completely eliminate the need for water softened by sodium exchange during the regeneration cycle cycle nor the need for step-wise acid injection to the cation exchanger to prevent precipitation of calcium sulphate. If hard water is used, there is always the possible problem of precipitating traces of magnesium hydroxide.

WHAT EXPERIMENTS SHOW

Experimental work shows that if hard water is used for regeneration, resistances obtained in the final effluent are about 2,000,000 ohms. If water free of magnesium is used, the resistance is in the range of 12,000,000 to 15,000,000 ohms. Therefore, a softener to supply magnesium-free water during the regeneration is recommended if a treated water is required with a resistance greater than approximately 2,000,000 ohms, or if the raw water contains more than 5 grains per gal. hardness. It is uneconomical to provide complete softening equipment prior to mixed bed deionization because of the greater original cost for equipment and the higher cost of regeneration. A small softener should be provided with the installation for solution makeup and for rinses during the regeneration cycle. Such a softener is inexpensive to operate and requires only infrequent regeneration.

All systems of deionization whether conventional two-bed, four-bed, or mixed bed are cyclic in character. After a certain period of operation the equipment must be taken out of service and the exchange materials regenerated by an acid or an alkaline solution. Acids most commonly used for regeneration of cation exchange materials are sulphuric and hydrochloric. If sulphuric is used initially at its most efficient concentration (6 to 8 percent) there is a tendency for the sulphate to precipitate during the regeneration cycle with the calcium ion adsorbed on the cation exchange resin. To overcome this, sulphuric acid can be applied to the spent cation exchange bed at 2 percent. At this concentration, precipitation will not occur, but the exchange capacity is decreased considerably. If 1.5 to 2 lb. of acid per cubic foot are applied initially at 2 percent concentration, the remaining sulphuric acid can be applied at concentrations of 6 to 8 percent with no precipitation. This technique removes the precipitation problem and gives an appreciable increase in the exchange capacity with the same amount of acid.

Hydrochloric acid removes the precipitation problem but is less economical than sulphuric acid. One hundred pounds of 18 deg. Be. hydrochloric will cost $1.55 and will be equivalent to approximately 44.65 lb. of 66 deg. Be. sulphuric which will cost only $0.4465. Thus it is highly desirable to use sulphuric acid, particularly in larger units.

* A. C. Reents and F. H. Kahler, *Ind. Eng. Chem.*, 43, p. 730 (1951).

LITTLE BONERS

The 10-Penny Baffle

The new synthetic rubber plant was completed and started up. It ran beautifully and was the pride of the company and its engineers.

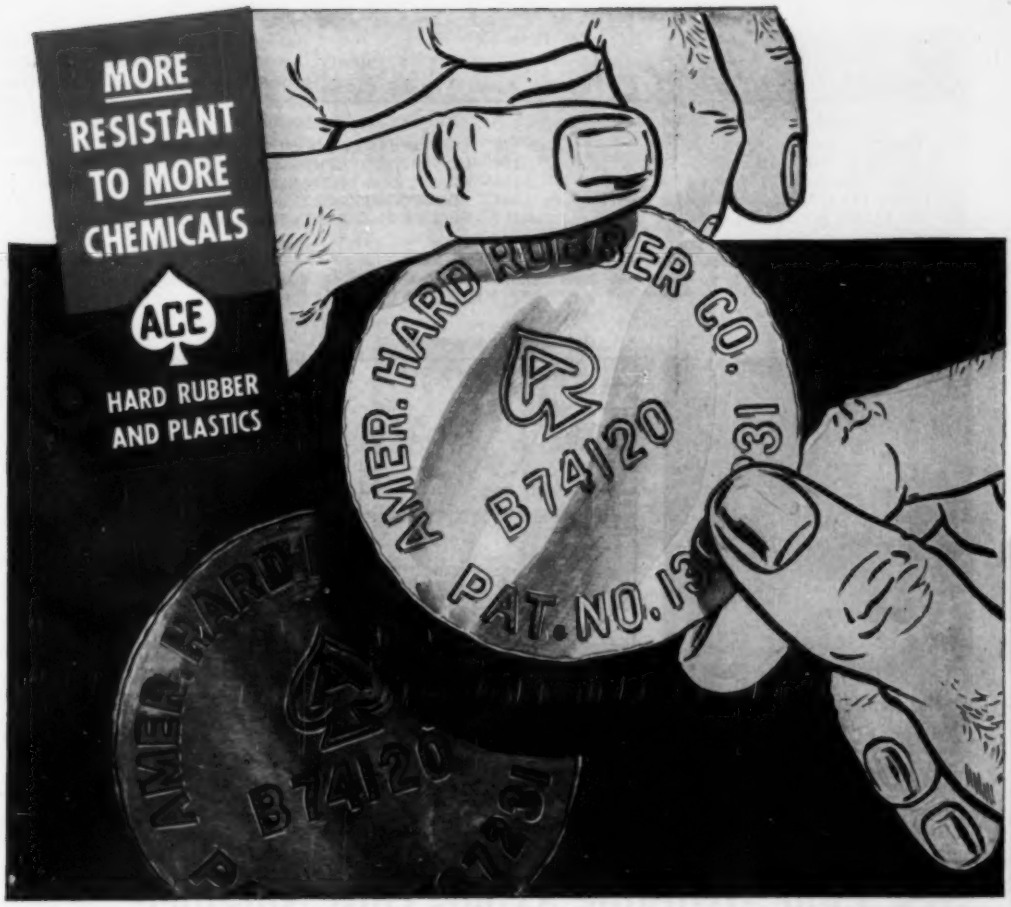
After a while the plant was shut down for a routine cleanup. Lo and behold, there was a sawhorse and a keg of nails right in the middle of the large tank that fed a big centrifugal pump.

The operators swore, then laughed and made uncomplimentary remarks about the carpenters who left them there. Unceremoniously, they heaved the keg and sawhorse onto the plant dump heap. Then they prepared to start up the unit again.

But instead of the smooth startup that the plant had shown before, there was trouble aplenty this time. Pressures fluctuated, levels surged, alarms sounded. It was found that the big pump was becoming gas-bound and losing its prime.

Once again the plant was shut down: this time so a baffle could be installed to cut down the swirl—a job that the old sawhorse and keg of nails had performed so well before!

This story comes first-hand from an operator who was there. "I know a couple of design engineers," he says, "who no longer make remarks about carpenters." Why not send in your true "little boner" story? Address: Editor, *Chemical Engineering*, 330 West 42nd St., New York 18, N. Y.



A CRAFTSMAN SIGNS HIS WORK

SOMEWHERE in every ACE rubber-protected tank you'll find this seal. It's embossed into the rubber by a skilled American Hard Rubber Company lining craftsman just before the tank goes into the vulcanizer.

The serial number tells the age, and an amazing number of old ACE tanks are still in service after years and years of trouble-free handling of acids and alkalies.

The laboratory-controlled quality of the rubber and the ACE two-layer lining process (shock-resistant soft rubber plus chemical resistant hard rubber) get part of the credit. No less important is the craftsmanship of the men who cement the bond—the men who roll the perfect seams—the men who "sign" the quality tank linings. Result: extra years of service, and lowest cost-per-year.

ACE rubber-protected tanks, pumps, valves, piping and special equipment are available for handling almost any acid or alkali. ACE Saran and polyethylene pipe and fittings also available. *Ask for catalogs.*

Process Equipment News · Edited by Cecil H. Chilton

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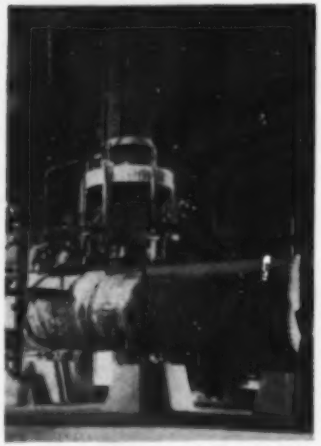
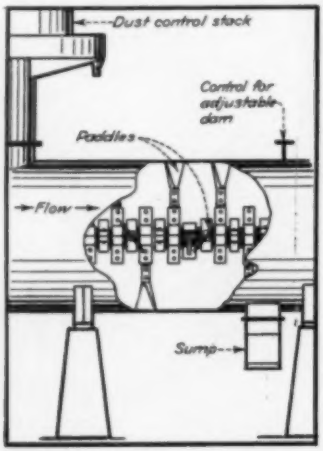
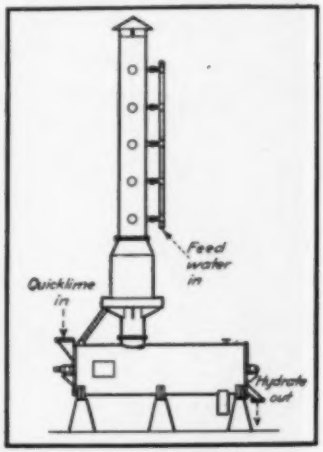
PROCESSING



DUST CONTROL STACK is visible in this picture of an actual installation.



CUTAWAY VIEW of the new hydrator, showing the paddle arrangement.



WATER OF HYDRATION is introduced at stack for dust control.

New Lime Hydrator Avoids Dust Nuisance

Hardinge combines most desirable features of older designs in its latest unit for hydration of quicklime.

(178A) The new lime hydrator recently announced by Hardinge Co. uses a novel arrangement for eliminating the dust nuisance usually associated with a lime hydrating plant. All the water required for the hydration reaction is sprayed into a dust control stack, where it wets down the dust emanating from the hydrator. The water and wetted dust fall down the stack into the hydrator, where the water reacts with the quicklime and the dust is recovered as product.

Development of this new hydrator is a good example of what might be called "inorganic evolution." It all began with the introduction of the Schulthess hydrator a number of years ago. By virtue of a series of corporate changes and acquisitions involving not only the Schulthess design but also several other makes of hydrators, Hardinge was able to obtain manufacturing rights for a number of various designs. Hardinge claims to have incorporated all the best features of its predecessors into the new hydrator.

The function of a lime hydrator is to produce hydrated lime (calcium hydroxide) from quicklime (calcium oxide) by reaction with the proper amount of water. Although the two types of lime can be used interchangeably in many cases, quicklime is handicapped by its instability in storage. Because of its tendency to react exothermically with moisture in the air, it must be stored in specially constructed air-tight tanks. Hydrated lime, on the other hand, can be stored without hazard in any place not actually exposed to the weather. Hydrate also has been found more suitable than quicklime in such chemical reactions as neutralization of acids.

The hydrator proper consists of a fixed horizontal cylinder equipped with a rotating shaft running its entire length. Paddles mounted on this shaft are properly spaced and pitched to provide the necessary mixing of lime and water in the various stages, beginning with the breakdown of raw quicklime at the feed entrance and ending with the discharge of hydrated lime at the opposite end.

A dam may be installed near the discharge end to vary the retention time of material in the unit. The dense, lumpy quicklime is retained by the dam, while the light, fluffy hydrate spills over to the discharge opening. The portions of lime which

hydrate more slowly are thus retained until they are completely hydrated. Although normal retention time is 12-15 min., variations can be obtained by adjusting the height of the dam. Material which refuses to hydrate collects in a sump, so designed that it can be emptied without shutting down the unit.

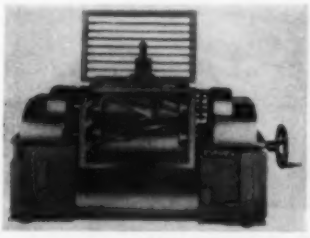
Four sizes of Hardinge hydrators are available, ranging from 1 to 5 tons per hr. rated capacity. The smallest is 42 in. in diameter by 12 ft. long and the largest is 60 in. in diameter by 22 ft. long. Minimum stack heights range from 16 to 23 ft.

The shell is constructed of steel plate. The longitudinal shaft is a square steel bar, turned on the ends (and in the center, if necessary) to accommodate the supporting bearings. The square shape provides a simple method of preventing the paddles from turning on the shaft, eliminating the necessity for keying. The cast iron paddles, which are subject to wear, are designed for easy replacement. They are arranged for both right- and left-hand pitch, in a proportion which will give the desired retention time in the hydrator.

CONTROLLED ACROBATICS:

Tumble Jar

(179A) Suitable for small mixing and tumbling jobs, a new tumble jar is offered by Andrew Technical Service. The unit consists of a 1-gal. glass jar with a Tygon-lined cap, rotated end over end at a normal speed of 55 rpm. by means of a gearhead motor and belt drive. Other speeds can be supplied to order, or the unit will be sold without the gearhead motor if operation is to be manual. At least one specific application is suggested by the fact that the unit conforms to specifications of the U. S. Quartermaster for dynamic absorption tests on textile coatings.

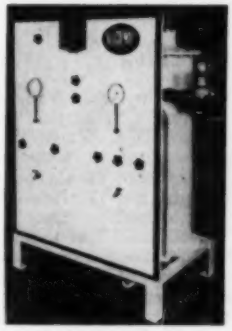


MIXES AND DISPERSES:

Heavy-Duty Kneader

(179B) The new Charles Ross & Son Co. 41L heavy-duty kneader is designed for maximum flexibility and versatility. Different types of mixing blades to suit the required service can be driven at equal or differential speeds. Tilting action can be manual, hydraulic, or motorized. An optional two-speed motor expedites thinning down prior to dumping. Other optional features include various types of covers and jackets for both cooling and heating.

The mixer is made in production sizes up to 150 gal. capacity and in 1-pt., 1-qt., and 2-gal. models for laboratory and pilot plant uses.



MIXED BUT NOT CONFUSED:

Water Treatment Units

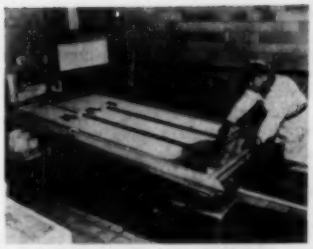
(179C) The Illinois Water Treatment Co. has recently announced a complete line of package deionizing water treatment units ranging in size from 12 to 1,000 gal. per hr. These units, utilizing the mixed bed principle, will produce water containing less than 0.1 ppm. total dissolved solids and less than 0.02 ppm. silica, it is claimed.

Marshall and Stevens Indexes of Comparative Equipment Costs

(1926 = 100)

Compiled quarterly for March, June, September, and December of each year by Marshall and Stevens, evaluation engineers, Chicago and Los Angeles. Indexes are prepared for 47 different industries, from which the eight process and four related industries listed here are selected. Published each month with the latest available revision. For a description of the method of obtaining the index numbers see R. W. Stevens, **Chemical Engineering**, Nov. 1947, pp. 124-6. For a listing of annual averages since 1913 see **Chemical Engineering**, Feb. 1951, p. 158.

Industry	Mar. 1950	Dec. 1950	Mar. 1951
Average of all.....	160.0	177.1	181.2
Process Industries			
Cement mfg.	155.5	169.5	174.0
Chemical	163.5	177.5	182.0
Clay products	150.5	164.5	169.0
Glass mfg.	153.6	167.6	172.1
Paint mfg.	156.8	170.8	175.3
Paper mfg.	157.1	171.1	175.6
Petroleum ind.	159.9	173.9	178.4
Rubber ind.	162.3	176.3	180.8
Process ind. avg....	160.9	174.9	179.4
Related Industries			
Elec. power equip...	165.1	179.1	183.6
Mining, milling	164.2	178.2	182.7
Refrigerating	174.8	195.8	201.0
Steam power	152.2	166.7	171.2



SARAN SCREENS STILLAGE

(179D) **This Rotex screen utilizes Lumite woven saran to screen residual mash from whiskey distilling operations at Seagram's Louisville plant. The screened byproduct is subsequently dried and sold as a livestock feed supplement.**

ATTENTION, PAPER MAKERS:

Automatic Emulsifier

(179E) A new, simplified automatic emulsifier for rosin size has been developed by Hercules Powder Co. This unit resulted from several years of experience and research, both in paper mills and in the Hercules laboratories.

The completely assembled unit occupies a space approximately 6 ft. square. Only labor required is routine preventive maintenance attention. Hercules supplies all equipment except the tank car unloading station and storage tanks.

FLUID FLOW

KEEP AIR CLEAN:

Ejector Valves

(179F) A new line of valves for automatic removal of contaminants from compressed air systems has been announced by the Wilkerson Corp. Claims made for the new valves include elimination of manual attention or adjustment as well as appreciable savings in repair and replacement of pneumatic tools and machinery.

FOR DOUBLE ACTION:

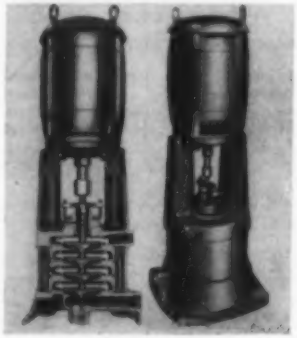
Solenoid Valve

(179G) A new double-operated solenoid valve for control of air and low pressure hydraulic cylinders has been designed by Airmatic Valve, Inc. This new model is for operation of double-acting cylinders where pressure must be held on one side of the cylinder for a given period of time. Also featured are built-in controls to govern speed of the cylinder. The valve may be reversed by momentarily energizing a single solenoid and the

(Continued)

cylinder may be held in position without the necessity of holding either solenoid energized.

The only moving part is a one-piece stainless steel spool which carries an O-ring seal. The new valve is available in full orifice areas of ¼ in., ⅜ in., and ½ in.

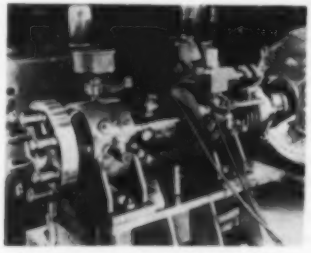


WITH TWO TO FIVE STAGES:

High-Pressure Pump

(180A) The Deming Fig. 6606 high-pressure pump is designed for general use where the liquids handled are non-corrosive to iron and bronze. Capacities range from 10 to 45 gpm. against heads up to 400 ft.

These pumps are furnished in 2, 3, 4, and 5-stage construction with 1¼-in. suction and 1-in. discharge connections. Motor sizes range from 2 to 5 hp. at 3,500 rpm.; pump and motor are built together as one unit. When specified, a mechanical seal can be furnished in place of stuffing box packing.



STRAIN GAGE TORQUEMETER

(180B) Allis-Chalmers expects to cut time and labor of testing centrifugal pumps by at least 60 percent by use of this new test stand employing a Baldwin torquemeter. Operation of the torquemeter is based on resistance wire strain gages bonded to a reduced section of a special alloy steel shaft at 45 deg. with the axis.

EITHER MANUAL OR AUTOMATIC:

Control Valve

(180C) The Annin Valve Co. has developed a valve that combines the advantages of a powerfully actuated control valve with the versatility of a handwheel valve. The control valve part uses the Annin Domotor operator with its direct-acting piston mechanism. A handwheel valve is mounted on the opposite side of the single-seated body.

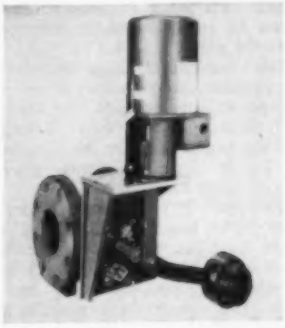
When automatic control is desired, the handwheel valve is opened fully and the Domotor takes over. During start-ups or instrument repair periods the handwheel provides positive manual control without changing valves. The handwheel may also be used as an adjustable limit stop for the automatic control valve plug.

The new combination valve is available from stock in a wide range of alloys. Pressures up to 3,000 psi. and temperatures of 1,000 deg. F. can be handled without difficulty.

NEW TYPE OF PERSUADER:

Valve Handwheel

(180D) A new cross-arm handle incorporating the impactor handwheel principle has been announced by Edward Valves, Inc. This device delivers 2.8 times the closing force of regular handwheels, it is claimed, and is especially useful for operating high-pressure valves. In operation, two lugs of the cross-arm handle strike equal blows simultaneously against opposite sides of the small adaptor, which is permanently attached to the valve stem. The handle is cast malleable iron and the adapter is drop forged steel.



FOR EMERGENCY SERVICE:

Rubber-Lined Valve

(180E) Developed by R-S Products Corp. for emergency gas or liquid shut-off service, heavy duty cast iron valve No. 763 employs a rubber seat. With the angular seating vane for wedge type closure, the rubber is compressed around the periphery of the vane to give positive shut-off even around the shaft bosses. This type of construction makes it possible to use an iron-body valve in service that would normally require stainless steel or other alloys. The rubber flanges take the place of the usual flange gaskets.

The valve is operated by a directly connected motor-driven pump, sealed in oil. Hydraulic pressure raises the counterweight for the open position. Upon failure of the current, the counterweight drops and the valve closes. Sizes are available from 2 to 72 in.

PACKAGING & HANDLING

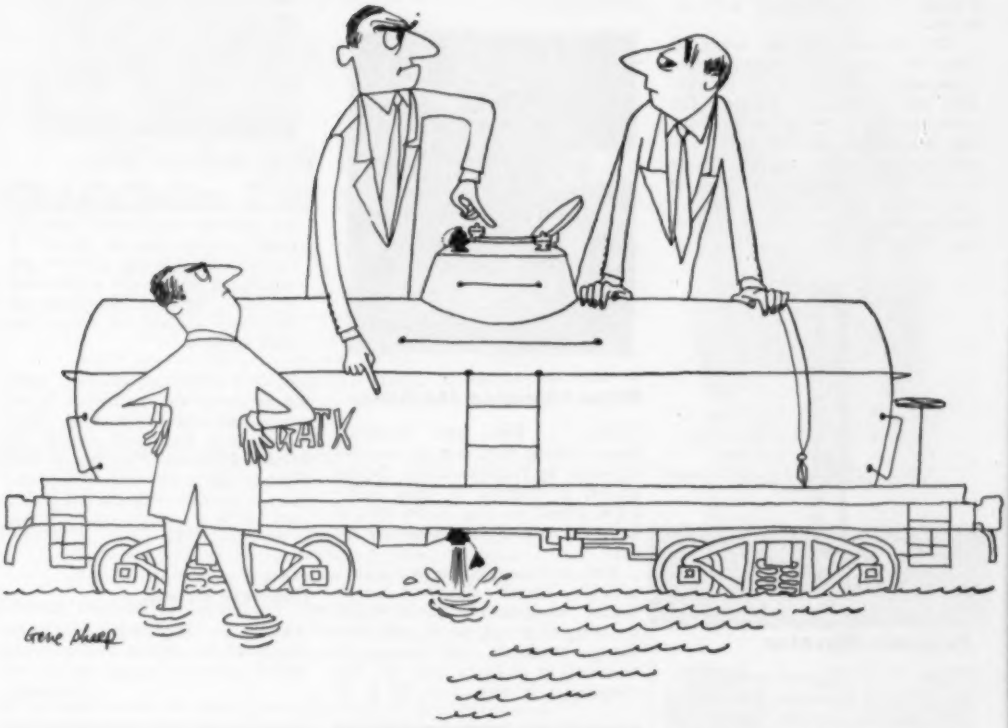
NO AIR LEAKAGE HERE:

Rotary Feeder

(180F) A new rotary airlock feeder for pneumatic handling sys-

(Continued)

THE CARE AND NURSING OF TANK CARS



Always load a car with the outlet valve cap off so that if the valve is leaking, the leak will show up immediately.

Another way to get more from your GATX tank cars

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tems has been announced by Prater Pulverizer Co. This device is designed to provide a positive and quantitative method of feeding powdered and granular materials into air conveying lines, hoppers, and processing equipment, and for sealing off air leakage at the discharge of dust collectors.

The cast iron rotor has machined slots for renewable rubber wiper strips which provide a tight, yet flexible, seal against air leakage. The rotor assembly is carried on ball bearings mounted on the end plates. The bearings are sealed against leakage on the outside with an additional oil seal on the material side to prevent leakage into the feeder and keep dust out of the bearings.

WITH SEVEN-FOOT LIFT:

Portable Elevator

(182A) Barrett-Cravens Co. has added to its regular line of portable elevators a model with a 7-ft. lift. The new unit is a standard item, manufactured on a production basis. It was developed to meet the need for a higher lift than was provided by the 5-ft. machine which formerly was standard in the 500-lb. capacity class.

FOR KRAFT OR CELLOPHANE:

Bag Closing Machine

(182B) Bemis Bro. Bag Co.'s latest development in the packaging field is a new closing machine which will close Deltaseal bags made of either kraft paper or cellophane. These bags have the handy pour spout known as the Deltaseal closure.

The complete unit requires minimum floor space and is entirely automatic. It consists of a shaker for settling the contents tightly and uniformly in the package; the closing unit; and a conveyor which transports the bags from the closing unit to the casing or baling station while allowing them to dry. Suitable adhesives insure tight closures, regardless of whether the package is constructed of plain or moisture-proof cellophane. If heat-sealing is desired, an additional heated belt arrangement may be obtained on which the packages travel under pressure.

NO CHEMICALS OR ALKALIS:

Drum Cleaning Machines

(182C) Two new Rotoblast drum cleaning machines are now being made by Pangborn Corp. Model ES-400 is designed to clean 1,000-1,100 drums per day; Model ES-382 has a capacity of 320-560 drums per day.

Both machines operate on the same principle. Metallic abrasive is thrown against the surfaces by vaned wheels, removing dirt, rust, paint, and other foreign materials, and leaving no chemicals or alkalis to wash off. The cleaning cycle takes from 50 to 90 sec., it is reported, depending upon the nature of the material to be removed and the facility with which the operator loads and unloads the drums. Spent abrasive, mixed with the material it has scoured from the drum, is cleaned of all dirt and broken particles by a separator and returned to the machine for reuse.

EXTRA-HIGH LIFT TRUCK

(182E) An extra set of front channels and an additional lifting cylinder enable this new Yale & Towne lift truck literally to "reach for the sky." It can tier loads to heights of 16 ft., permitting full utilization of available storage space. The extra attachment can be quickly removed for normal fork truck operation.

WORKS IN NARROW AISLES:

Electric Truck

(182F) A platform Transtacker almost 10 in. shorter than previous models has been designed by the Au-

(Continued)

NEW RUBBER DRUM CAN BE COLLAPSED AFTER EMPTYING

(182D) U. S. Rubber Co. has developed a new 55-gal. synthetic rubber-fabric drum, suitable for shipping liquids, which can be collapsed after emptying. This new drum should effect sizable savings in return shipping costs, since more than 2,500 collapsed drums can be shipped in a standard railroad box car that would hold only 300 rigid drums. It is made of Ustex cord fabric, impregnated with synthetic rubber and molded in one piece. As shown in the picture at the left, the drum automatically collapses as liquid is withdrawn, requiring no venting. With the addition of a metal plate, as shown at the right, it can be completely emptied from an overhead hanging position. Limited quantities of the new drum are already being produced for essential uses in the petroleum and chemical fields.

CORROSION CHECKED IN CAUSTIC LIQUOR LINES ...AND ELSEWHERE

...WITH 18-8 MO TRIMMED CRANE ALLOY CAST IRON GATES

These Crane low nickel alloy cast iron valves give excellent results in many services where conventional "all-iron" and "brass trimmed" valves fail because of corrosive conditions. Today, they are also finding wider application on mildly corrosive services, or services where some corrosion is permissible, as substitutes for the more expensive, hard-to-get, all 18-8 stainless steel valves. In design and in materials, Crane No. 14477 valves have many value-adding features like these:

STEM THREADS ARE OUTSIDE VALVE BODY—not exposed to erosive and corrosive effects of line fluids; simplifies thread lubrication.

ACCURATE, TIGHT SEATING—extra long disc guides keep disc travel true; minimize drag on seating surfaces. Screwed-in shoulder type body seat rings do not loosen in service.

PROVED CORROSION-RESISTANT MATERIALS—Body seat rings, stem, and disc faces are 18-8 Mo; packing gland is nickel-plated steel; body, bonnet, and disc are nickel low alloy cast iron.

EXTRA RESISTANCE TO LINE STRAINS assured by tie ribs between end and bonnet flanges. Husky body-bonnet flanges use more bolts of smaller diameter to equalize pressure on gasket for maximum safety and tightness.

SEND FOR CIRCULAR NO. 320 for complete information about these—and other—Crane corrosion-resistant piping materials. Ask your Crane Representative for your copy, or write direct. No obligation.

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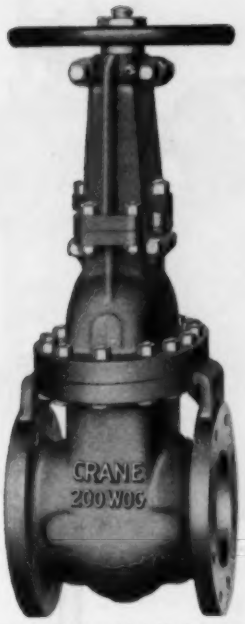
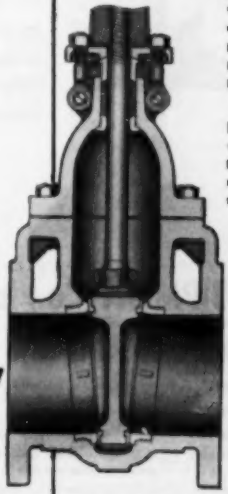


No. 14477 Gate 18-8 Mo Trimmed.
Working Pressure: 200 pounds cold water, oil, or gas.
Sizes: 2 to 12 inch. Flanged Ends.

Easy to operate... Easy to service



BOLTED PACKING GLAND with swinging eye bolts equalizes pressure on packing; permits easy pull-up; prevents stem binding.

DEEP STUFFING BOX with two-piece ball-type gland and flange maintains tight stem seal.

T-HEAD DISC-STEM connection prevents side strain on stem; gives flexibility for smooth operation.

STRAIGHT THROUGH PORTS assure unrestricted flow; minimize turbulence and corrosive action.

Cross-section No. 14477

EVERYTHING FOR EVERY PIPING SYSTEM

CRANE

VALVES • FITTINGS • PIPE • PLUMBING AND HEATING

SPEEDS ARE CHANGED in a few minutes, by removing the cover and changing the two easily accessible gears.

up to 16 SPEEDS quickly interchangeable in this standard LIGHTNIN MIXER

When your fluid agitation requirements change, this *Series E* LIGHTNIN MIXER can change to meet them.

The new gearbox design gives you a choice of as many as 16 standard AGMA output speeds—from 16.5 to 420 RPM—all interchangeable in a few minutes' time, without special tools.

This and other LIGHTNIN features like *independent shaft suspension, interchangeable mountings,* and *standard interchangeable impellers,* give you real versatility to meet future needs. Lightnin Mixers *stay* useful in your plant —long after other mixers have become obsolete.

MIXCO engineers can show you how to cut processing time and boost output, with fluid agitation correctly adapted to your process. Their services include accurate prediction of the results you will get. Finally, every Lightnin Mixer is guaranteed to do the job for which it is recommended. For complete information, call in the MIXCO representative in your area, or write us today.

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Please send me the literature checked:

- ☐ B-76 Side Entering Mixers
- ☐ B-78 Top Entering Mixers (Propeller Type)
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- ☐ DH-50 Laboratory Mixers
- ☐ B-36 Condensed Catalog showing complete line
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LIGHTNIN PORTABLE MIXERS

World's largest-selling line. Electric or air motor, direct or gear drive. Sizes ¼ to 5 HP.

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For tanks up to 5 million gallons. Gear motor or V-belt drive; motorless types. Sizes 1 to 25 HP.

LIGHTNIN TOP ENTERING AGITATORS

Turbine, propeller and paddle types. For open or closed tanks. 16 speeds available in new heavy duty drive. Sizes ¼ to 500 HP.

A COMPLETE LINE . . . UNEXCELLED TECHNOLOGY

tomatic Transportation Co., permitting its use in narrow aisles. The new model is made in 4,000 and 5,000-lb. capacities. Lift is 70 in. and mast height is 83 in.

CONSTRUCTION MATERIALS

SYNTHETIC FIBERS SCORE AGAIN:

Dynel Work Clothing

(185A) Work clothing made of dynel staple by Chem Wear, Inc., is reducing clothing replacements in acid and caustic plants by as much as 75 percent, according to customer reports. Comparative tests of dynel clothing vs. cotton and wool garments in the $AlCl_3$, $ZrCl_4$, and $TiCl_4$ departments of Stauffer Chemical Co. indicate extremely long life expectancy. Whereas cotton clothing lasted less than one 8-hr. shift when exposed to excessive fumes, dynel garments have lasted several months.

The acid resistance of dynel clothing compared with cotton is shown in the above picture. Both shirts were placed in 60 percent H_2SO_4 for 2 min., then washed and dried.

LOOK FOR THE SILVER LINING:

Silver-Clad Steel

(185B) A laminated strip product consisting of a core of mild steel, clad on one or both sides with a solid sheet of silver, has been developed by the American Silver Co. This material is available in widths up to 4 in., in thicknesses down to 0.005 in., and in any required temper. It is being manufactured in various silver-to-steel thickness ratios. Although it is not a product of electroplating, it can be plated directly with other metals.

Excellent thermal and electrical conductivities and the high resistance of silver to attack by alkalis and organic acids make this product of interest to the process industries. It can be shaped by stamping, bending, drawing, spinning, and other conventional metal-working processes.

PRESSURE VESSEL FOR LIQUID N_2

(185C) Six stainless steel plates were welded into a spherical shape to form this pressure vessel, designed to store liquid nitrogen used in Air Force rocket experiments. Fabricated by Research Welding & Engineering Co., the sphere is 54 in. in diameter, has a wall thickness of 3/16 in., and is capable of withstanding 5,500 psi. at −340 deg. F.

EASILY FABRICATED:

High-Temperature Alloy

(185D) Haynes alloy No. 25 is a new wrought high-temperature material with excellent mechanical properties at temperatures up to 1,800 deg. F., yet is ductile enough at room temperature to facilitate fabrication. This combination of properties makes it suitable for the construction of highly stressed parts that must operate at elevated temperatures. It is available as sheet, plate, bar stock, and tubing.

Short-time tensile strength at 1,800 deg. F. is over 20,000 psi. Stress required for rupture at 1,000 hr. is 17,000 psi. at 1,500 deg. and 4,500 psi. at 1,800 deg.

HEATING & EVAPORATION

FOR QUIET MIXING:

Steam-Water Diffuser

(185E) A new all-bronze steam-water diffuser, made by O'Brien Steam Specialty Co., is designed to produce hot water by the quiet mixing of steam and cold water. The unit employs staggered holes in concentric inner and outer shells to break the steam into numerous small paths. It is made in 1- and 1½-in. sizes.

HEAT IS WHERE YOU WANT IT:

Portable Electric Oven

(185F) Grieve-Hendry Co. has added a new model to its line of portable electric ovens. It is provided with four shelves which can accommodate eight 2-in. deep by 12-in. wide by 23-in. long drying pans. Materials can be placed directly on the shelves, if desired. The oven operates on 110-volt power supply.

GUINEA PIG UNIT:

Dryer-Flaker

(185G) Drying or flaking problems can be solved on a new experimental atmospheric dryer-flaker developed by Lukens Steel Co. This unit is suited for operation with different heating and cooling mediums, at speeds up to 50 rpm., and internal pressures up to 200 psi. Interchangeable corrosion-resistant rolls of single- or double-shell construction are provided for making heat transfer and other tests under actual production conditions. Feed is applied by any method desired and product is removed from the rolls by a knife. A suitably constructed hood eliminates dust and fume hazards.

The purpose of the unit is to provide engineering data which will assist in reducing costs and improving performance of similar machines used in the process industries. Lukenweld dryers and flakers feature jacketed rolls of welded steel construction. The manufacturer reports that production increases up to 67 percent have been realized by switching from conventional rolls to Lukenweld jacketed rolls.

COMPOSITION MEASUREMENT

FOR METALLURGICAL ANALYSES:

Direct-Reading Spectrometer

(185H) Applied Research Laboratories has developed a direct-reading spectrometer, designed for testing metals and other inorganic materials. Based on spectroscopic principles, it

(*Continued*)

provides recorded analyses of samples, element by element, within two minutes or less. The recording mechanism can produce multiple copies of these records for high-speed analytical control.

CARRY IT WITH YOU:

Pocket pH Meter

(186A) A new pocket-size pH meter and companion probe unit permit instant, on-the-spot pH determinations. Supports and beakers are completely eliminated by combining the calomel and glass electrodes with the sample holder in a single polyethylene probe unit. The instrument is completely self-contained and weighs only 3 lb. Hearing-aid type batteries provide up to 1,300 hrs. of operation.

The meter is scaled from 2 to 12 pH; a simple adjustment gives readings from 0 to 14. Accuracy of 0.1 pH is claimed by the manufacturer, Analytical Measurements, Inc.

FOR CHECKING HIGH-VACUUM SYSTEMS:

Leak Detector

(186B) A new inexpensive leak detector made by Distillation Products Industries is designed for users who have only occasional need for a leak detector and whose purpose is merely to establish the presence of a leak too small to be detected by more obvious signs. It operates on the principle that the tendency of hot platinum to emit positive ions is enormously stimulated by small traces of halogens or their compounds. The compound usually used is Freon gas. The instrument may be used in vacuum systems down to 1 micron Hg.

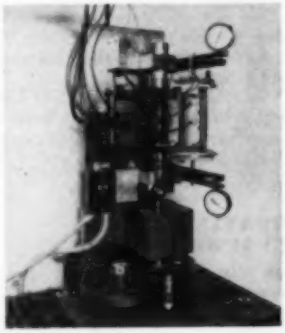
All you do is seal the sensitive element into the system being tested and bring the interior a little below atmospheric pressure. Then you direct a small jet of Freon at suspected spots and watch the meter.

PROTECTS REMOTE AREAS:

Combustible Gas Alarm

(186C) The instrument division of Davis Emergency Equipment Co. has developed a combustible gas alarm system to protect from four to eight separate plant locations. Operation of the unit is based on a timed mechanism which draws samples into the analyzer through connecting tubes from each of the danger spots. A complete tour of a four-point system takes 2 min., while an eight-point cycle requires 4 min. The system can be used with complete safety where a dangerous concentration of vapor cannot build up to an explosive level faster than the touring cycle of the system and where the vapor pressure of the combustible is high enough to prevent condensation in the sample lines.

The unit employs the new thermocouple type filament, in which filament temperature rather than resistance is measured. This principle of detection is described more fully on p. 150 of our January 1951 issue.



VISCOSITY TESTER

(186D) This imposing looking gadget is the improved McKee worker-consistometer, designed by the National Bureau of Standards to measure the effect of mechanical working on the physical properties of lubricating greases. Recent improvements have extended the range of the instrument to higher viscosities, making it possible to study the rheological properties of rubber and rubber solutions as well as greases and similar substances.

FOR HIGH-PURITY WATER:

Conductivity Cell

(186E) Measurement of the very high specific resistances of deionized water can now be made with new instruments available from Industrial Instruments, Inc. Resistances as high as 18 megohms can be measured.

INSTRUMENTATION—GENERAL

EASY ON THE EYES:

Weightograph

(186F) The Howe 77 Weightograph, which can be used with any make beam scale, features a nonprotruding periscope with a convenient eye-level screen. The weight is indicated in large illuminated figures for easy and accurate reading. It is attached to the beam shelf and connected to the beam with a rod.

Optical design of the unit is intended to increase image brightness and contrast five times over older models. The image is read off a mirror instead of a ground glass screen, contributing greatly to the readability of the image under all sorts of light, including daylight. Life expectancy of the prefocused projection lamp is 1 yr. under normal usage, it is claimed. A bayonet lock insures accurate position of the filament.

WITH PLUG-IN CONNECTIONS:

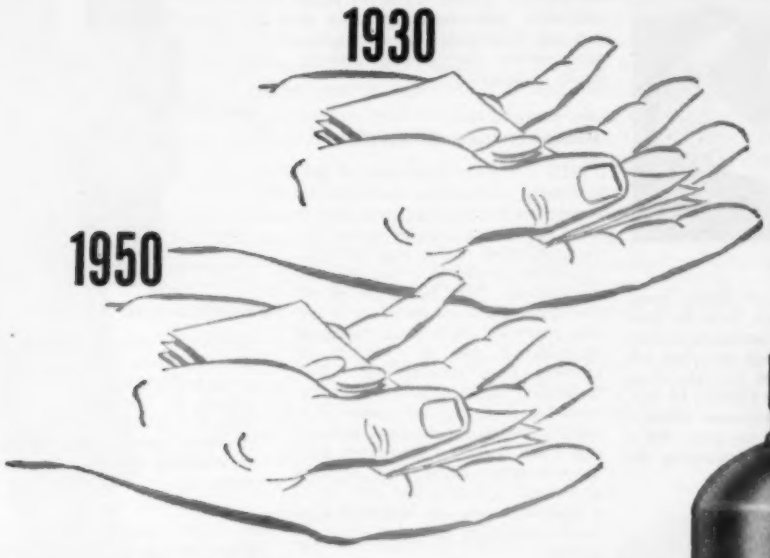
Controlling Pyrometer

(186G) The new Simplytrol controlling pyrometer, supplied by Assembly Products, Inc., features a large 4½-in. meter to give better readibility and improved appearance. Plug-in connections between the control and the terminal board make it easy to remove or replace the instrument without disturbing any permanent connections.

The contact relays are readily interchangeable for different temperature ranges. Eight available ranges provide control bewteen −75 and 3,000 deg. F.

(Continued)

HACKNEY LIGHTWEIGHT CYLINDERS



it costs NO more to ship

150 lbs. of anhydrous ammonia today than in 1930...even though freight rates are up 41%!

Hackney Lightweight Cylinders offset higher freight rates for many products. These facts about anhydrous ammonia shipments illustrate possible savings to all compressed gas manufacturers.

In 1930, it cost a shipper $4.64 to send 150 lbs. of anhydrous ammonia from St. Louis to Dallas. Freight rates for carload shipments were low ($1.16 per 100 lbs.), the cylinder was heavy (250 lbs.).

In 1950, it cost a shipper $4.65 to send 150 lbs. of anhydrous ammonia from St. Louis to Dallas. Freight rates are higher ($1.63 per 100 lbs.), *but the cylinder is lighter* (135 lbs.).

Not only that... it costs about 25% *less* to return the empty cylinder *today*, a definite economy.

Hackney Lightweight Cylinders, fabricated from high strength steels, give you cost-saving light weight, with no sacrifice in strength. The Hackney Deep Drawing Process assures uniform sidewall thickness and eliminates all excess weight.

If you're still using old, bulky, hard-to-handle cylinders, change to lightweight Hackney Cylinders. It's the way to shipping and handling economies. Write us for further information.

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PRESSED STEEL TANK COMPANY

Manufacturer of Hackney Products

1447 S. 66th St., Milwaukee 14
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203 Hanna Bldg., Cleveland 15
936 W. Peachtree St., N.W., Room 113, Atlanta 3
208 S. LaSalle St., Room 792, Chicago 4
553 Roosevelt Bldg., Los Angeles 14

CONTAINERS FOR GASES, LIQUIDS AND SOLIDS

TIN PLATE TESTER

(188A) This new device, developed by U. S. Steel, tests tin plate uniformity without having to sacrifice any material. Enough tin plate will be saved annually at the Gary works alone to manufacture a million tin cans, it is said. The instrument measures x-rays reflected from the sheet with a Geiger counter, thus determining the thickness of the tin coating.

FOR HEAVY-DUTY APPLICATIONS:

Platform Scale

(188B) The Load King, a new Yale & Towne platform scale, is designed primarily for heavy-duty applications where shock loading is expected. The lever system and other key parts are constructed of steel. Poises on the main bar are mounted on roller bearings for rapid positioning. The scale gives the same reading regardless of the location of the load on the platform, it is reported.

Pit requirements for the Load King are only 11 in., saving considerable expenditure on excavation when the scale is installed. It is built in capacities up to 6,400 lb. Platforms range from 46 × 38 to 76 × 54 in.

ENGINEERS' DREAM COMES TRUE:

Function Plotter

(188C) The automatic compiling of two measurements and plotting of a curve to show their interrelationship is made possible by a new Minneapolis-Honeywell instrument. The function plotter incorporates two measuring systems—one of them actuates the recorder pen while the other motivates the instrument chart. With this arrangement, the chart is driven up and down in response to changes in one variable simultaneously with movement of the pen in response to changes in a second variable. The result is a curve which continuously evaluates one variable in terms of the other.

Engineering investigations involving such interdependent non-linear variables are greatly facilitated with the function plotter. Point by point tabulation and manual plotting of data are eliminated. The continuous curve makes interpolation between points unnecessary.

GETS RID OF ZIG-ZAG:

Temperature Controller

(188D) The equivalent of proportioning control may be added to any type of heating equipment already using conventional on-off control by the installation of the new Wheelco Capaciline, according to a recent announcement. The magnitude of cyclic temperature variations in a system controlled by a standard on-off controller is due to a variety of inherent heat transfer lags. The Capaciline anticipates and compensates for these lags by means of a suitably designed electrical network and relay circuit synchronized with the measuring system. It is available as a small self-contained unit or as a built-in feature of Wheelco electronic controllers and strip chart recorders.

ONE CHART, SIX RECORDS:

Strip Chart Recorder

(188E) Wheelco Instrument Co. is now in production on a new multipoint Capacilog. This electronically operated unit, a deflection type strip chart recorder, provides up to six permanent records on a single chart. Primary sensing elements may be thermocouples, radiation detectors, etc.

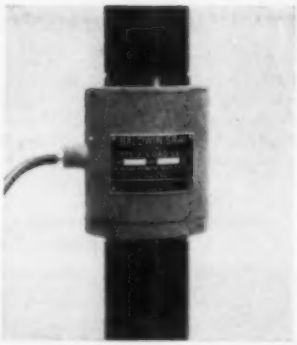
The deflection system is a direct-reading, non-balancing method of detecting changes in a measured variable. It achieves results heretofore obtainable only through the use of potentiometric or null type systems. An accuracy of 0.25 percent of scale is claimed.

IMPROVED HEARING AID:

Voltage Stabilizer

(188F) Accurate control of the operation of ball, pebble, and rod mills by means of the Hardinge Electric Ear requires a reliable power supply. In this system of control, noise from the mill is measured by the Electric Ear, and the operator adjusts the feed rate to keep the mill running at maximum efficiency. Accurate operation of the device is seriously affected by line voltage variations.

The Sola Electric Co. is now supplying a constant voltage transformer for incorporation into the Electric Ear unit. This instrument puts out a constant voltage in spite of variations in the input voltage over a range of 95 to 130 v., improving the reliability of the control system.



TENSIONAL LOAD CELLS

(188G) Baldwin load cells, based on resistance wire strain gages, are made in standard load capacities of 10,000 to 100,000 lb. The largest of these new units is 15 in. long and 3 in. in diameter at the threaded ends. They are used for measuring weights or forces in tension.

PRECISE AND DURABLE:

Stopwatches

(188H) Meylan Stopwatch Co. is now building several new improvements into all their stopwatches. Greater accuracy over longer periods is provided, Meylan claims, with an improved balance wheel assembly in jewel bushings. A new double whip lever provides faster starts. Sturdiness is increased by a new full barrel bridge. A stronger and more securely positioned dial prevents shifting with slight shocks.

FUN FOR DIAL TWISTERS:

Temperature Regulator

(188I) The calibrated dial now available on Leslie Class T and M self-contained temperature regulators provides quick and dependable temperature settings, according to a recent announcement. A simple turn of the dial to the temperature desired is all that is needed. The calibration eliminates the need for waiting for the equipment to heat up to find out if the setting is correct.

The dial fits in place of the standard adjusting sleeve. It can be easily installed on regulators already in service.

(Continued)

USE AIR *instead of liquids* FOR COOLING

While the principle of air-cooling in heat exchangers is not new, its adaptation on a large scale in industry is being recognized more and more. Air as a coolant can be used under certain conditions with greater economy and higher efficiency than is practical with liquids.

The advantages of air-cooling are readily recognized in cases where ample water supply is not available, where such water may cause scale or premature corrosion, or where treatment required for the water would prove expensive. Many more advantages will suggest themselves.

One of the major components in all air-cooled heat exchangers is, of course, the tubing. And the tubing that deserves serious consideration in such applications naturally is Wolverine Trufin* (the integral finned tube)—and specifically the bi-metal Trufin. This tube has aluminum fins and copper liner, which latter can be supplied in most copper base alloy specified to accommodate the contacting fluids. Obviously, such factors as corrosion, pressure, etc. determine the type of liner and composition of the tube that would prove most efficient.

Since the fins of Trufin are integral with the outer tube itself, they stand upright and remain in a fixed position. Moreover, because there is a good mechanical bond between the two metals, very little loss of efficiency is experienced regardless of the type of liner.

There is much specialized experience here at Wolverine upon which you are invited to draw for help in solving problems involving heat exchangers.

Shown here are two views of an air-cooled heat exchanger installed in the south by Hudson Engineering Co. Nearly a quarter-million square feet of surface area is represented in the installation of Wolverine Trufin—the integral finned tube. This bi-metal Trufin was specifically developed for this air-cooling application and is the direct result of the study of conditions found there by Wolverine's Customer Engineering Service.

*Reg. U. S. Pat. Off.

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Calumet & Hecla Consolidated Copper Company
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Manufacturers of seamless, non-ferrous tubing
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Wolverine Trufin and the Wolverine Spun End Process available through the Unifin Tube Co., London, Ontario

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PRESSURE & FLOW MEASUREMENT

WATCH THE DROPS GO BY:

Flow Detector

(190A) An instrument for measuring the rate of flow of discrete particles of liquids or solids is available from Rochester Electronics Co. When a particle impinges on a probe, a voltage is generated by a transducer to which the probe is coupled. This voltage is amplified and then peak-detected. The detector thus provides one pulse of controlled width for each particle hitting the probe. Probes are shaped for particular applications and can be changed in a few minutes.

SELF-CONTAINED AND PORTABLE:

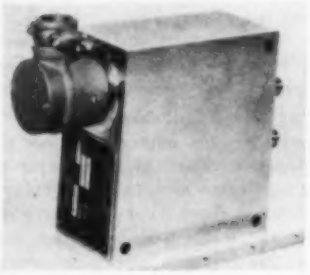
Air Velocity Meter

(190B) A new portable air velocity meter with a range of 0-4,000 fpm. has been announced by the Hastings Instrument Co. Using a self-contained battery power supply, it operates from a probe-mounted noble metal thermopile. Readings are not affected by the length of the cable from the probe to the instrument, it is claimed. Measurements of static pressures up to 4 in. water are provided by the use of a pressure attachment which mounts on the probe. The complete instrument weighs 11 lb., is available in either a mahogany or aluminum carrying case.

NO TIPPING, PLEASE:

Pressure Gage Bleeder

(190C) Bleeding of air from Bourdon pressure gages without tipping the gage is now possible, using a new bleeder tube made by the Heise Bourdon Tube Co. The tube, available in most Heise gages, extends from the highest point on the Bourdon tube to an external block containing a vent screw on the back of the case. Removal of the screw permits air to escape. When the pressure medium begins to escape through the vent, the screw is replaced, and the gage is ready for use.



ANOTHER STRAIN GAGE APPLICATION:

Differential Pressure Cell

(190D) The new Baldwin-Lima-Hamilton differential pressure cell consists of a pair of matched Monel pressure bellows arranged to apply opposing forces on a cantilever beam to which SR-4 resistance wire strain gages are bonded. The sensing element is hermetically sealed by solder in an aluminum box. Electrical connections are made through glass-to-metal seals. The cell is insensitive to linear acceleration in any direction and may be mounted in any position without affecting pressure indications.

Two pressure ranges are available: ±10 and ±20 psi. Maximum permissible line pressures are 50 and 100 psi., respectively. Cells are designed for the standard 120-ohm circuit and for 300-ohm circuits. Recommended input voltages are 6 v. and 12 v., with maximums of 8 and 16 v., respectively.

In addition to differential measurements of liquid and gas pressures, these cells may be used for measurements of flow, liquid level, etc.

HIGH SENSITIVITY:

Pressure Switch

(190E) A new pressure-actuated switch, designed to respond to very small changes in pressure, is made by F. W. Dwyer Mfg. Co. This switch is suitable for indicating pressure drops in air filters and across coils, to indicate power or blower failures, to warn against unsafe or uneconomical operating conditions, and for use with pitot tubes to indicate air velocities above or below standard or safe values.

It is made in two models. Model 1620 has a minimum setting of 0.25 in. water with a gap between make and break of 0.20 in. water or greater. Model 1625 has a minimum make-break gap of 0.05 in. water in the lower settings, 10 percent or more of the setting in the higher ranges. Switches may be mounted in any position. They are rated at 10 amp., 110 v. a.c.

REQUIRES NO MERCURY:

Flow Transmitter

(190F) A compact and lightweight transmitter, designed for sensitive measurement and control of fluid flow, has been developed by Minneapolis-Honeywell. The new differential converter has a continuously adjustable range from 0-20 to 0-200 in. water and provides changes in range with no change of parts. Field calibration of any range is possible by the use of weights, eliminating the need for water columns.

Operating on the pneumatic balance principle, without mercury, the differential converter employs an accurate weigh-beam system in which the differential pressure is continuously balanced by a pneumatic pressure. This latter pressure, a measure of the rate of fluid flow, is piped to a recording or controlling instrument.

The unit is offered in 750 and 1,500 psi. ratings in Type 316 stainless or carbon steel.

AIR CONDITIONING & REFRIGERATION

INDEPENDENT OF WEATHER:

Power Roof Ventilator

(190G) The Ilg Electric Ventilating Co. has brought out a new power roof ventilator, known as Type PRV, consisting of a housed direct-connected centrifugal fan and motor. The new unit provides positive controlled ventilation independent of wind or weather conditions. It is offered in 11 sizes, each one available in two to four different speeds.

Heart of the PRV is its self-cooled

(*Continued*)

D.O.James

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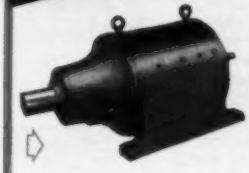
GEARED DRIVES MEET GROWING DEMANDS FOR POWER-SAVING EQUIPMENT IN INDUSTRY

Available in either Horizontal or Vertical Drive

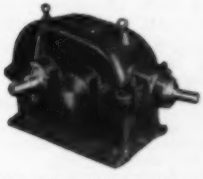
Continuous-tooth Herringbone
Single, Double, Triple Reduction

Type "H" Worm Gear



Straight Line Gear Reducer

Motorized Reducers



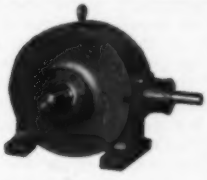
Spiral Bevel Herringbone

Double Worm Gear

Helical Worm Gear

Motorized Worm Gear

Right Angle Gear Reducer



Spiral Bevel Gear

D.O.James Gear Manufacturing Co. is constantly developing and continuing to improve its variety of gear speed reducers—enabling engineers and designers of power-saving equipment to meet and cope with space limitations, horsepower requirements, ratios, location of driven or driving shafts and the type of drive that the many and varied installations require. Catalogs are available containing complete informative engineering data that will assist in the selection of the type of reducer for the specific job to be done.

D.O.JAMES GEAR MANUFACTURING CO.

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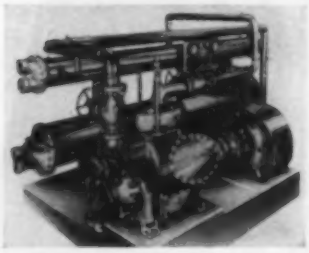
motor. Positive pressure ventilation is provided to cool the motor and motor compartment with outside air.



MOTOR, ENGINE, OR TURBINE DRIVES:

Refrigeration Machines

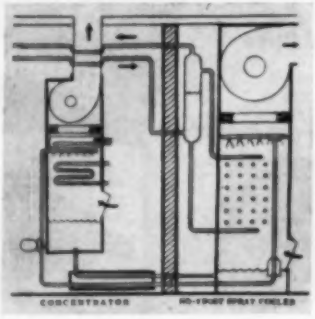
(192A) Two new reciprocating refrigeration machines for use in the 100- to 150-ton range have been announced by Carrier Corp. Although the machines are supplied in complete packages, compressor design permits the economic selection of a wide range of drives. Belt drive or direct drive with flexible coupling may be used with electric motors or gas or diesel engines. Geared steam turbine drives, where applicable, may prove to be economical.

The units include compressor, cooler, condenser, interconnecting piping, fittings, safety and capacity controls, gage board, and cooler and condenser stands. Special design of pipes and fittings achieves an unusual compactness of assembly. Both cooler and condenser have easily removable cast iron water boxes which permit quick brush cleaning of all tubes. The exchangers operate with refrigerant in the shell and water in the tubes.

Although particularly suitable for air conditioning purposes, the machines are adaptable to various industrial requirements, such as direct product cooling, brine chilling, and ammonia and chlorine condensing.

AIR FRESHENER

(192B) Although this 3-ton capacity room conditioner continually recirculates the air in the space, with no outside air intake, freshness is maintained by two activated carbon panels on the return air entrance of the unit. Ventilation is thus maintained without the necessity of bringing in new unconditioned air; this would require a lengthy duct installation and also an increase in cooling capacity. Activated carbon air recovery units are made by W. B. Connor Engineering Corp.



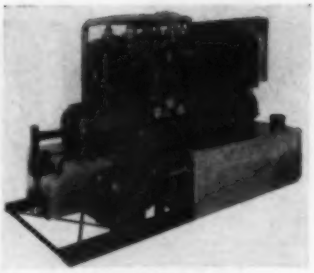
NO FROSTING ON COILS:

Cooling System

(192C) Niagara Blower Co. has introduced a new unit for refrigerating storage areas, test rooms, and processing areas. Accumulation of ice or frost on the coils is prevented by a constant spray of a nonfreezing liquid. In order to keep the process automatic and continuous, this liquid is maintained in a concentrated condition by removing excess water in a new type of concentrator.

Air is drawn by fans over heating coils and through the concentrating chamber. The dilute solution is sprayed into the chamber, where the hot air assists in the evaporation of water. The new concentrator replaces older types in which water was removed by heating the solution above the boiling point. It has the advantages of operating at lower temperature, smaller space requirements, and less shut-down time for cleaning and maintenance.

With this equipment it is possible to refrigerate to temperatures as low as −30 deg. F. without interruption for defrosting, it is claimed. Additional refrigerant coils may be used to obtain even lower temperatures. It is planned to manufacture these units with water evaporating capacities ranging from 0.5 to 75 gph.



COMPLETE AND READY TO GO:

Water Cooling Unit

(192D) A new water cooling unit, made by Mayer Refrigerating Engineers, Inc., is sold as a complete, self-contained package, ready for connection to water and power lines. Typical cold water applications for these machines, known as Chil-er units, are air conditioning systems, mill and calender rolls, molding machines, and hydraulic systems. Capacities available range from 4.7 to 106 tons refrigeration at 40 deg. F., or 6.0 to 155 tons at 55 deg. F. These ratings are based on using 1½ gpm. of 75 deg. condenser water per ton. Ratings based on 3 gpm. per ton of 85 deg. condenser water are slightly lower.

The unit includes a high-head, high-volume water circulating pump, storage tank, and complete auxiliary equipment, assembled on permanent steel skids. No foundation or bolting down is necessary, according to Mayer. Operation is entirely automatic. The unit can be used with brine to obtain subfreezing temperatures.

FOR DUST-FREE ATMOSPHERES:

Air Filter

(192E) Formation of a new jointly owned company to manufacture the air filter described on p. 105 of our Aug. 1950 issue has been announced by Arthur D. Little, Inc., and Carrier Corp. The new company will be known as Cambridge Corp.

Single filter units can be built to handle 1,000 cfm. at pressures within the capacities of central station air conditioning systems. The new filter will be particularly useful wherever air must be completely dust-free or sterile, as in the manufacture and assembly of precision devices or in hospitals, biological laboratories, and pharmaceutical plants. The filtering medium is a special soft and feltlike paper containing sub-microscopic asbestos fibers which direct the air through tortuous paths so that essen-

(*Continued*)

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Bulletin #9041... 32 pages of data, photos and drawings in color describing the Dorrco Hydro-Treator... the high-rate water treatment unit that gives these results

PLANT	JUNCTION CITY, KANSAS	[illegible], OHIO	APPLETON, WISCONSIN	A CANADIAN PAPER CO.	T.V.A., [illegible], ALABAMA
OPERATION	SOFTENING	SOFTENING	SOFT. COLOR & TURB. REM.	COLOR REM.	ALGAE & COLOR REM.
NO. & SIZE OF UNITS	2-60' DIA.	1-21' DIA.	1-45' DIA.	2-60' DIA.	1-28' DIA.
CAP. PER UNIT, M.G.D.	1.5	1.0	3.1	10.0	2.0
GAL/SQ. FT./MIN.	1.00	.93	1.38	1.39	1.07
AVG. TURB. EFF. PPM	LESS THAN 5.2	5.0	2.4 TO 4.7	2 TO 5	6 TO 7
[illegible]	33 TO 44.5	24.9 TO 29.2	16.7	-	-

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ALUMINUM BRASS AND BRONZE!

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ALBERT PIPE SUPPLY CO.

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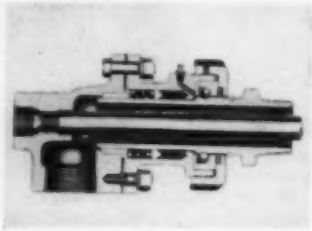
tially all the particles become entangled in the fibers. Large sheets of this paper are folded in accordion fashion and fitted into a frame, thereby providing a large filtering surface in a relatively small space.

ELECTRICAL & MECHANICAL



LOW TORQUE SAVES POWER:

Revolving Joints

Two manufacturers of revolving joints are introducing new designs. In both cases they claim very low turning torques, thus making possible savings in power. These joints are used for making piping connections to drum dryer rolls, calenders, and other rotating equipment.

(194A) The Barco joint illustrated above is designated as Type IBR. The rotating portion of the joint consists of a special precision-machined and heat-treated steel tube which screws into the hub of the drum or roll. The non-rotating portion is ball bearing mounted on this tube. Specially designed ball bearings carry the loads of both radial and end thrust. Use of a sleeve pilot bearing at the end of the rotating tube insures alignment of the joint. Self-adjusting, self-sealing chevron packing carried under light spring pressure provides the seal on the rotating tube.

The new joints are built for 150-lb. steam service, 200-lb. hydraulic service, and also for vacuum service. They can be used for speeds up to 500 rpm. (steam) or 750 rpm. (hydraulic), and for temperatures up to 450 deg. F., depending on packing specified. Standard sizes range from ¼ to 2 in.

(194B) Rotherm Engineering Co.'s new model will be made in all sizes from ¼ to 5 in. This one basic design can be used on applications that will require rotating siphons as well as standard applications where condensate is removed through the same end of the roll as the steam is introduced.

The joint is entirely self-contained. Rotation takes place on a flat carbon

face which has a ball surface that corrects tendency of the roll to weave due to eccentricity. This ball surface also reduces the possibility of breakage of the carbon ring, because all shock would have a tendency to compress the carbon rather than to pull it apart when under pressure.

USES TWO BELTS:

Variable-Speed Drive

(195A) A line of extra heavy-duty motor-drives for variable speed service has been developed by U. S. Electrical Motors, Inc. To carry loads up to 50 hp. through the internal speed changing transmission, a dual belt arrangement is employed, thus distributing the load so that no undue strain is imposed. To counterbalance belt load, a tension control is provided.

NO RUST, NO BUST:

Electrical Fittings

(195B) Killark Electric Mfg. Co. has introduced several new lines of electrical fittings featuring corrosion-resistant and explosion-proof construction. Die-cast Alumalloy fittings have shown good corrosion resistance when exposed to acid fumes, chemical atmospheres, and weather. They possess another advantage over iron fittings—they weigh 40 percent less. The complete line of explosion-proof fittings includes light fixtures, switches, boxes, etc.

WITH BUILT-IN BRAKE:

Gearhead Motor

(195C) Sterling Electric Motors, Inc., has recently introduced a totally enclosed, fan-cooled gearhead motor with motor-mounted disk type brake. The brake can be supplied for either stopping or holding service.

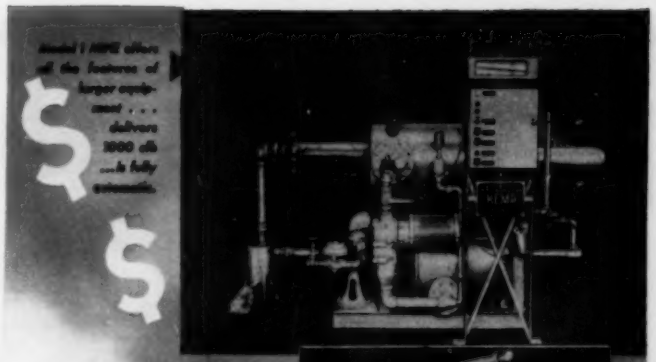
Both motor and brake are totally enclosed and dust tight, being especially designed for use in atmospheres containing non-explosive dust, vapors, and other injurious foreign materials. The new drive is made in 2 to 15 hp. ratings and in AGMA speeds from 30 to 280 rpm.

FOR PUSH-PULL CONTROL:

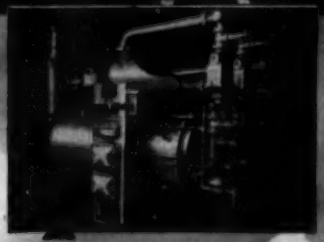
Pneumatic Cylinder

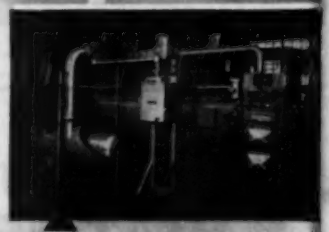
(195D) Conoflow Corp. has announced the B-50 series of pneumatic cylinders for throttling control service. This series is suitable for use with air supply pressures up to 100 psi. Repositioning accuracies equivalent to 0.2 percent of the total travel are claimed. Typical applica-

(Continued)



It pays to GENERATE your own INERTS





Kemp Inert Gas Generators Save $9 of the $10 you now spend for Inerts

Need inerts for purging, fire protection, mixing, blanketing or a special application? You can save up to 90% on Inert Gas costs when you generate your own inerts with a Kemp Inert Gas Producer. The cost of transportation, bottle juggling, storage, deposits on cylinder inventories and the initial higher cost of bottled nitrogen or CO_2 is eliminated.

ABSOLUTELY DEPENDABLE

No matter what the demand, Kemp Inert Gas Generators give you the same analysis Inert Gas from 20% to 100% of capacity. The Kemp Industrial Carburetor, part of each installation, burns ordinary gas just as it comes from the mains. Assures complete combustion without "tinkering." Produces a clean, chemically inert gas to meet your most exacting requirements.

SEND FOR DATA

Whatever your requirements, always specify Kemp. *To find out how you can benefit:* Tell us your atmosphere gas problem, and we'll show you how Kemp can solve it and save you money!

KEMP OF BALTIMORE

INERT GAS GENERATORS

Write for Bulletin I-10 for technical information C. M. KEMP MFG. CO. 405 E. Oliver St., Baltimore 2, Md.

What's your tank problem?

Take our word for it, there's a Stainless Steel SAN-I-TANK — standard or special, big or little — that will solve your tank problem. Here are two standard tanks, for example, that show what we mean:

Type "CJ" is an open top, jacketed, stainless steel tank that can be used for every kind of hot or cold processing. Jacket is warranted to 150 p.s.i. working pressure. Tank can be equipped with side, bottom or top-entering agitators and all types of fittings and connections. Capacities: 60 to 1000 gallons. Write today for Bulletin JS-50.

Type "H" is a horizontal SAN-I-TANK designed to handle large quantities of liquids in minimum overhead space. This is a stainless steel, single-shell. For mixing, blending or storage purposes, it may be equipped with top or end-entering agitator and any type of connections. Available in capacities ranging from 200 to 4500 gallons. Write today for Bulletin SS-50, describing this and other single shell tanks in detail.

STAINLESS STEEL SAN-I-TANKS

METAL GLASS PRODUCTS COMPANY

BELDING 5, MICHIGAN

New York Chicago Atlanta San Francisco Los Angeles Seattle New Orleans

Large Processor Achieves

MORE UNIFORM HEATING CYCLES

with Nicholson Steam Traps

The positive action of Nicholson traps was recently used successfully by a chemical maker to smooth out the heating cycles of cookers at 50 to 60 minutes, against previous periods up to 105 minutes. Steam flow was upped to 3000 lbs. an hour against 2000 for the previous mechanical type.

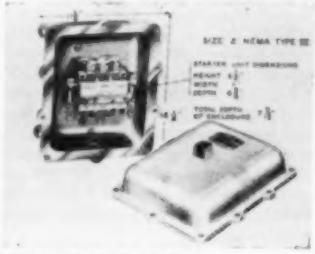
5 TYPES FOR EVERY APPLICATION, process, heat, power. Sizes ¼" to 2"; pressure to 225 lbs. To learn why an increasing number of leading plants are standardizing on Nicholson thermostatic traps . . .

Send for BULLETIN 450 or see Sweet's

W. H. NICHOLSON & CO., 206 Oregon St., Wilkes-Barre, Pa.

tions are the positioning of adjustable drives, adjustable stroke pumps, and sliding stem valves.

The cylinder itself is made of cast aluminum. The one-piece piston is fitted with a graphite-impregnated O-ring; head plate and piston stem are also O-ring sealed.



SMALL SIZE SAVES SPACE:

Magnetic Starters

(196A) The Arrow-Hart & Hegeman Electric Co. has announced a new line of magnetic starters featuring a compact design. Less than ½ the size of other makes, these starters are claimed to be the smallest on the market. Another feature is light weight. It is said that one man can carry and install a size 2 starter without a truck or chain hoist. The new starters are available in sizes 0 through 4.

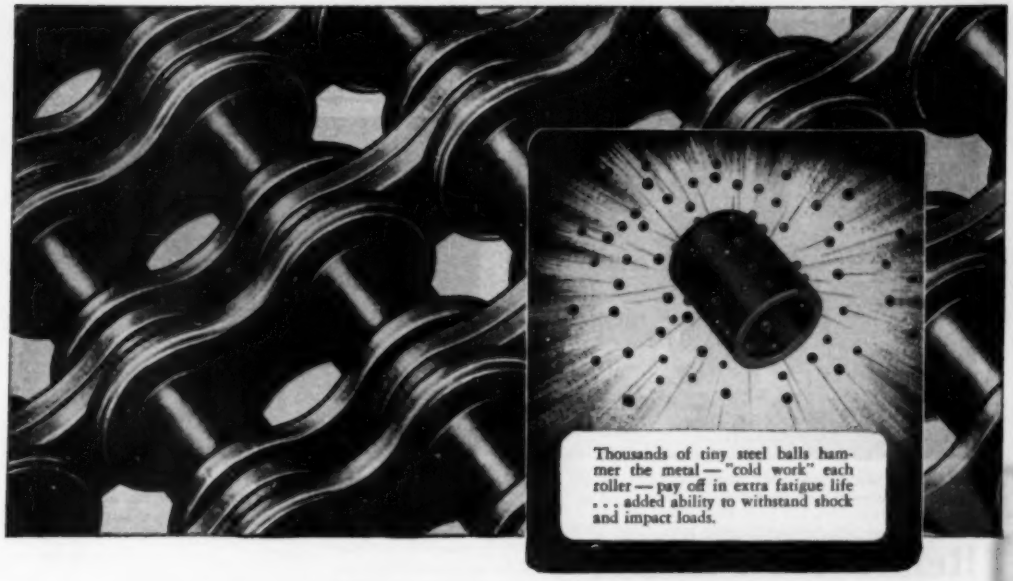
Compactness and light weight are obtained through use of a new right-angle mechanism within a specially designed Feraloy cast housing. As indicated by the name Exploso-Safe, these starters are suitable for installation in hazardous locations. The special alloy housing possesses high tensile strength and corrosion resistance; it is designed to withstand severe internal pressures.

Terminals are front wired for straight-through wiring and are accessible without removing overlapping parts. All wires can be cut even without bending or preforming. Location of heaters and overload relays aids visual inspection and speeds up servicing.

FOR VARIABLE-SPEED DRIVES:

Electric Tachometer

(196B) A new tachometer for use with its line of variable-speed drives is now offered by Reeves Pulley Co. Operating on the a.c. generator principle, the indicator may be mounted as far as 300 ft. from the drive itself. Inasmuch as the new tachometer is comparable in price to older mechanical models and is more accurate, manufacture of the mechanical type has ceased.


Thousands of tiny steel balls hammer the metal — "cold work" each roller — pay off in extra fatigue life . . . added ability to withstand shock and impact loads.

Why you should be sure the roller chain you buy has

SHOT-PEENED ROLLERS

. . . one of the extra-strength features you get with every LINK-BELT Roller Chain

Look for the distinguishing darkened rollers on every roller chain you buy! They're your guarantee of extra fatigue life.

Shot-peening is just one of the added manufacturing refinements that make Link-Belt Precision Steel Roller Chain a longer-life chain. Controlled material selection and heat treating assure absolute uniformity . . . no weak members.

Link-Belt Roller Chain is available in single or multiple widths, in ⅜ to 3 in. single and double pitch. For the best in roller chain, get in touch with your nearest Link-Belt office.

Easier coupling and uncoupling without sacrificing load distribution

Patented E-Z Assembly feature of Link-Belt Precision Steel Roller Chain has won world-wide approval. Coupling and uncoupling of multiple width chains—right on the job—is far easier. There's absolutely no sacrifice of load distribution . . . no loss of the chain's remarkable performance. Press-fits between chain pins and middle bars have been modified. But full load-carrying capacity across the entire width of the chain has been maintained.

LINK-BELT

PRECISION STEEL ROLLER CHAIN

LINK-BELT COMPANY: Indianapolis 6, Chicago 9, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices, Factory Branch Stores and Distributors in principal cities. 12.500

MILITARY uses include boats, planes, landing mats, etc. Colonel K. J. Kramsie poses with boat Army is justly proud of.

CIVILIAN embodiment could be in such things as airplane rudders even though these were designed for military planes.

Reinforced Plastics, Structural Materials to Watch

You won't be able to get metals you need, but in some applications, structural plastics are better. Trouble is these aren't abundant either. Combined availability of both may be answer. (198A)

It may well be a case of jumping from one frying pan into another but we thought that when you start hunting for metals substitutes, you ought to know about the wondrous things they're doing with reinforced plastics.

In case you haven't been following this youngster, reinforced plastics are polyester resins, usually laminated with fibrous glass, hemp, sisal, rayon or the like. The reinforcing material may be either woven or undirectional. Glass is the preferred material because of its chemical resistance, strength, moisture resistance and elasticity. Many of the earlier production difficulties have been ironed out, and at least four major firms are now in glass fiber production and twelve are making polyester resins.

Born of World War II, production of polyesters blossomed to 6 million pounds by 1945, shrunk to slightly over 2 million after the war and had rebounded, stretched and climbed to 8 million pounds by 1950. Now with the gage pointing to war again, it's anybody's guess where the industry goes from here.

One thing is sure, though. Its leaders aren't going to be caught with their plants down—styrene shortages be hanged! Not long ago they proudly held their first annual session as a division of the Society of the Plastics Industry. At that Chicago meeting, these leaders of the Reinforced Plastics Division showed some ambitious products, some already proved, others hopeful.

Manufacturers*

Polyester Resins

American Cyanamid Co.
New York, N. Y.

Pittsburgh Plate Glass Co.
Pittsburgh, Pa.

Rohm & Haas Co.
Philadelphia, Pa.

U. S. Rubber Co.
Naugatuck, Conn.

Libbey-Owens-Ford Glass Co.
Toledo, Ohio

Atlas Powder Co.
Wilmington, Del.

Shell Chemical Corp.
New York, N. Y.

Union Carbide & Carbon Co.
New York, N. Y.

General Tire & Rubber Co.
Akron, Ohio

Glass Fibers

Owens-Corning Fiberglas Corp.
Toledo, Ohio

Glass Fibers, Inc.
Waterville, Ohio

Perrault Glass Fibers, Inc.
Newport, Ark.

Glasfloss Corp.
Hicksville, N. Y.

* Not a complete listing.

Naturally, emphasis was on the military, but these industrialists are keeping an eye, if not a bankroll, on the civilian market.

In the works and pretty well proved were things like radomes, some small, others as big as a small elephant. Big advantage of the plastics here, is the fact that radio and radar beams are able to transpierce the materials. Guided missiles, too, being able to penetrate an enemy's radar screen undetected, are a natural for such materials.

Boats are another production item. A 28-ft. personnel boat has emerged shipshape after a year and a half of active duty. Many smaller personnel boats are coming off the lines in rapid sequence and a 36-ft. landing craft of steel and reinforced plastic is under construction for the Navy.

All sorts of shelters for personnel, planes, cars and trucks are coming out of the molders' plants, and more and more items are added to the list each month. We've only touched on them here.

Among those that look promising but need much more work are things like landing mats for planes. So far the upper strength limit of the materials is a wheel load of 20,000 lb.

while the Army wants it to go up to 80,000 lb. Then there's the problem of jet exhaust which melts the mats.

Plastic pipes are on the list too. Army engineers are looking for a 6-in. pipe which would be ⅛th the weight of iron and steel—but heat resistance and leakage are problems yet to be solved.

These are just a few of the developments among reinforced plastics. With shortages of materials and personnel, with lack of engineering data, prejudice from designers, understandable timidity from the military, and pressure from the metals makers, it's going to be a long, tough road. But no one is doubting that the industry will make it. You can't laugh off 8 million pounds of resin a year.

3,3'-Aminobispropylamine

Useful in the synthesis of ion exchange resins. Potential intermediate in dyes, drugs, surface active agents. (199A)

The new product development department of American Cyanamid Co. announces the availability of 3,3'-aminobispropylamine in trial-lot quantities. This compound is a colorless, high-boiling, strongly basic amine. It is completely miscible at room temperature, with water and most common organic solvents.

As indicated above, its potentialities as an intermediate for the preparation of surface active agents, pharmaceuticals and dyestuffs should be investigated, since its linen structure and the three-carbon separation between amine groups differentiate it from other available polyamines.

Filler for Rubber

Aluminum silicate with particle size comparable to some carbon blacks. (199B)

Witcosil 40, a reinforcing filler for rubber compounding, has been placed on the market by Witco Chemical Co.

Basic ingredient is aluminum silicate of about 106 Angstroms. This is comparable to MPC and HMF carbon blacks and it is this fineness that imparts desirable reinforcing properties to compounds made with this product as a filler.

Good flex resistance with very low heat build-up, tensile and abrasion properties comparable with carbon black, and superior aging can be attained by the use of Witcosil 40.

The product is light gray in color, with a pH of 8 (very close to furnace blacks) and a specific gravity of 2.35.

Slime Controlling Compound

Keeps industrial cooling waters clean. Experimental quantities. (199C)

Product is Santophen 45, a technical grade of sodium trichlorophenate. Laboratory tests and field trials in large cooling water systems have shown it to be highly effective against bacteria and algae, common slime forming organisms. Monsanto Chemical Co. is the producer of the compound.

Slime and debris trapped by slime, may seriously interfere with the flow of water and the efficiency of re-circulating cooling water systems. Chemicals such as chlorine, hypochlorites, copper sulphate and sodium pentachlorophenate have been used to control the formation of such deposits.

The trichlorophenols liberated by Santophen 45 are soluble in acid waters, and capable of maintaining the necessary activity against slime producing microorganisms while some control agents are not.

Molykote Lubricants

We've had a tremendous response to our stories on molybdenum-based lubricants (Jan., p. 163; Feb., p. 184). Here's a new one. (199D)

Molykote Type G is a grease compound containing mainly Molykote Type Z powder (highly purified molybdenum disulphide), which is processed with a high grade of lubricating oil and a stabilizer. Alpha Corp. is the maker.

The main functional properties of the material may best be explained if we compare them with the action of successful special purpose E. P. lubricants containing chemical additives. These additives are designed to initiate, by chemical reaction with the bearing metal, solid metallic films of low shear strength.

However, the formation of such solid metallic films by chemical reaction takes place only if a narrow range of specific conditions occur. The type of bearing metal, rubbing velocity, specific conditions of shear, bearing pressure, heat, and the type of additives in the lubricant in combination, must be favorable to the formation.

It is obvious, therefore, that such E. P. lubricants are custom-tailored to a specific application, and are not intended for general purposes.

Molykote Type G by comparison, does not depend on chemical reaction to furnish the solid metallic films of low shear strength, so necessary when extreme bearing pressures exist. The material for such films is the major constituent of the lubricant itself, and this metallic constituent, molybdenum disulphide, as processed in Molykote Type G, has an affinity for attachment to all types of metal surfaces, independent of temperature.

Among the many possible applications where Molykote Type G will excel conventional lubricants, the following examples are indicative of cases where the margin of superiority can be expected to be large:

Power screws, toggle joints, threaded connections, tapers, wedges, lathe centers, assembly and break-in lubricant for new machinery, gears, etc.

New Synthetic Rubber

Excels natural and synthetics for oil seals, gaskets, fuel tanks, linings, etc. (199E)

Lactoprene BN, a rubber with outstanding resistance to dry heat, aging, water, oils and low temperatures has been developed by the Department of Agriculture. Product is said to maintain its desirable physical properties from −30 deg. F. to 300 deg. F., is similar to Lactoprene EV developed for high-temperature resistance and now in commercial production.

The new rubber is made from butyl acrylate and acrylonitrile.

Impure Sodium

With 15-25 percent calcium. Low-cost IF you can use it. (199F)

A sodium-calcium combination product, normally re-cycled in the

(Continued)

New This Month . . .

	Page & Item
Reinforced Plastics	198A
3'-Aminobispropylamine	199A
Filler for Rubber	199B
Slime Controlling Compound	199C
Molykote Lubricants	199D
New Synthetic Rubber	199E
Impure Sodium	199F
Thread Compound	200A
Ductile Bismuth Wire	200B
Asphalt Softener	200C
Blackout Tape	200D
Vinyl Latex	200E
N-Bromoacetamide	202A
Corrosion Inhibiting Wax	202B
Improved Vitamin A	204A
Non-Melting Waxes	204A
Moisture Remover	206B

More Information . . .

To find out more about any of these new products, circle the item's number on Reader Service Postcard inside the back cover.

manufacture of metallic sodium, has been made commercially available by National Distillers Chemical Corp.

The company, which produces metallic sodium by the electrolysis of sodium chloride, offers the combination product as a low-cost source of metallic sodium, or for reactions where the calcium content of the product will prove advantageous.

Typical analysis (by weight) of the combination product is: sodium 65-75 percent; calcium 15-25 percent; sodium monoxide 10 percent; and chlorides 1 percent.

The product is shipped in brick form, packed dry in 55-gal. drums.

Thread Compound

Prevents seizure of pipe, bolt and stud threads, gasket faces. (200A)

A new metallic compound which combines the advantages of a lubricant and sealer to solve this problem has been developed by Armite Laboratories of Los Angeles. It is an anti-seize compound known as Led-Plate, with effective results when used at temperatures from −350 deg. F. to 2,900 deg. F.—and even higher according to Armite.

The metallic elements, over 70 percent powdered lead, are held in suspension in hydrocarbons, and the materials will not dry out. This insures later disassembly without seizure. No graphite is used.

Compound can be used for steam, gas, water, air, oil, ammonia and various chemical connections. Product conforms to government specifications.

Ductile Bismuth Wire

Brittleness and lack of tensile strength largely overcome. Unique electrical properties. (200B)

The successful production of ductile bismuth wire and ribbon by the Fitzpatrick Electric Supply Co. has been recently reported. The company claims to have bismuth ductile enough to wind on its own diameter at room temperature, or about 70 deg. F. However, its tensile strength is low—has to be handled with care—that is, not subjected to a strain exceeding its tensile strength. Keeping this in mind, it is possible to wind coils, make non-inductive prods, transformers, etc., without failures.

The possibilities of development in the control and instrument fields by the use of ductile bismuth are great. Bismuth has no near competitors and offers the following characteristics to a much higher degree than any other material.

1. Resistance change in a magnetic field. This opens up an automatic voltage control, controlled output in watts, etc., overcoming errors due to voltage drop, instrumentation, calculators, fogging of x-ray pictures due to voltage variations, etc. Any quantity of current can be controlled through tubes.

2. Voltage change due to Hall effect. Locating ferrous metals, submarines, for alarm systems, signals and many other applications.

3. A variable rectifier; in fact, the only variable rectifier known. What its uses will be is unknown, but it will be used in the near future.

4. Hot and cold junction for instrumentation, refrigeration, etc.

5. Most negative material known for thermocouples; exceeds all others by over 100 percent, giving −69 microvolts per deg. C. change against platinum from 0 to 100 deg. C.

6. Best material for resistance (ohms) change due to temperature change for instrument control. 720 ohms/mil ft. Makes possible the use of a small amount of wire for giving an appreciable change in resistance per degree.

7. 95 Bi, 5 Sn also ductile. Most positive alloy known for thermocouples, giving +57 microvolts per deg. C. change against platinum 0 to 100 deg. C.

8. 95 Bi, 5 Sn is better than pure Bi for resistance ohm change having a resistance of 2,150 ohms/mil ft.

BLACKOUT TAPE

New luminescent tape developed by Century Coating Co., glows in the dark. Tape uses a plastisol made from Geon paste resins. (200D)

ASPHALT SOFTENER

Roads can be re-built twice as fast and at half the cost with the new rejuvenating process of Shell Oil Co. Machine collects the old, broken asphalt, pulverizes it, mixes it with the liquid petroleum softener, and then lays it down as a "better-than new" road surface. (200C)

Vinyl Latex

For textile, paper and paint industries. Coating material, pigment binder. (200E)

A new vinyl latex for use in the paper, textile and paint industries has recently been offered to the trade by the Dow Chemical Co.

Called Dow Latex 744-B, this new product is now in commercial production. The new latex is designed to serve both as a functional coating material and as a pigment binder. It

(Continued)

How Celite Mineral Fillers give a product low-cost bulk . . .

Making a little cleanser go a long way

SINCE HOUSEHOLD CLEANSERS are one of many products that require bulk in order to do their work efficiently and economically . . . it is not surprising to find Celite Mineral Fillers used as a standard ingredient in quality cleansers.

The reason is the great bulk per unit of weight of Celite Mineral Fillers . . . as well as their exceptionally low cost per unit of volume. In addition, they have a high absorptive capacity for perfumes and chemicals. Celite's porous, thin-walled cellular structure, from which these advantages are derived, adapts these diatomaceous silica powders to numerous industrial uses.

THESE CELITE PROPERTIES BENEFIT MANY TYPES OF PRODUCTS

Celite Mineral Fillers are composed of minute, multi-shaped particles that interlace to stiffen and strengthen admixtures. The microscopically small facets of these particles diffuse light so effectively that they can be utilized to impart any desired degree of flatness to a surface film. Their light, porous nature improves suspension, helps prevent segregation. Their high absorption properties and unique diatom structure make them unusually effective for overcoming caking in deliquescent materials.

If you are looking for the "extra something" to lift your product above competition—at no extra cost—why not discuss your problem with a Johns-Manville Celite Engineer? For further information and samples, write Johns-Manville, Box 290, New York 16, New York. In Canada: 199 Bay Street, Toronto, Ontario.

CHECK LIST OF PRODUCT BENEFITS OBTAINABLE AT LITTLE COST WITH CELITE MINERAL FILLERS

- Added Bulk
- Better Suspension
- Faster Cleaning Action
- Greater Absorption
- Improved Color
- Better Dielectric Properties
- More Durable Finish
- Increased Viscosity
- Elimination of Caking
- Higher Melting Point
- Better Dry Mixing
- Improved Dispersion

Johns-Manville CELITE®

MINERAL FILLERS

Points the finger at Hidden fires...

Slow-burning fires may smolder for hours before they generate enough heat to set off fire detecting devices. But they can be spotted within a few seconds by a *Kidde* smoke detecting system.

A single *Kidde* Multi-line Smoke Detector System can protect one room or many rooms in the same building. A central electronic control board tells the exact location of the fire—and transmits a warning to your fire control headquarters or the local fire department.

You can combine this efficient *Kidde* Smoke Detector System with a *Kidde* CO_2 Fire Extinguishing System. See your nearest Kidde representative or write for full information.

Walter Kidde & Company, Inc.
528 Main St., Belleville 9, N. J.
Walter Kidde & Company of Canada, Ltd.
Montreal, P. Q.

Kidde

gives resistance to moisture, chemicals and grease in functional paper coatings. It also will produce durable, fire and chemical resistant paints, fabrics and coated wall board, the company says. It is weather resistant, a desirable property for tent, awning and tarpaulin coatings. The new product is finding widespread use for military application in the textile, paint and paper fields.

N-Bromoacetamide

In addition to brominating olefins in the "allyl" position, product oxidizes secondary alcohols to ketones with specificity. (202A)

Called NBA for simplicity, *N*-bromoacetamide has been of interest to the steroid chemist for many years. But now Arapahoe Chemicals, Inc., has announced that for the first time it is preparing the chemical in commercial quantities.

Curiously enough, NBA was the first compound ever used for producing "allylic" brominations, more than twenty years before Ziegler introduced its now famous cousin, *N*-bromosuccinimide (NBS) for that purpose. The wide acceptance of NBS led the company to undertake the commercialization of other N-halogenated compounds. NBA is its most recent introduction in this field.

Up till now the use of NBA has been restricted to the laboratory because published methods for its preparation have generally been considered unsatisfactory and stability has been poor. The new product is described as a white powder containing 57.9 percent active bromine and it is reported to be stable for reasonable periods of time if kept in tightly closed containers at moderate temperatures.

In addition to brominating olefins in the "allyl" position, NBA oxidizes secondary alcohols to ketones with specificity. NBA is also able to add HOBr or Br_2 to double bonds depending upon the conditions employed. Nearly quantitative yields result from the use of NBA for the addition of bromine to olefins.

Corrosion Inhibiting Wax

Non-toxic. Meets Defense Dept. Spec. Mil-C-10382. (202B)

A new, non-toxic corrosion inhibitor to meet government specification on the manufacture of food handling equipment has been developed by S. C. Johnson & Son, Inc.

The company says that the mate-

(Continued)

Heyden

PARASEPTS®

(ESTERS OF PARAHYDROXYBENZOIC ACID)

Products subject to deterioration through bacterial and fungal action—cosmetics and creams, pharmaceuticals and pastes—need "purity insurance" to maintain sales preference and prestige. Heyden PARASEPTS have proven themselves reliable allies of industry and research in preventing spoilage of products containing oils, fats, gums or carbohydrates—through effective preservation that means permanent protection of quality.

Five PARASEPTS are listed here. They are available in technical as well as purified grades. Shipped in 100, 50, and 25-lb. fiber drums.

METHYL PARASEPT
(Methylparaben U.S.P.)

ETHYL PARASEPT

PROPYL PARASEPT
(Propylparaben U.S.P.)

BUTYL PARASEPT

BENZYL PARASEPT

Technical information and samples supplied upon request.

HEYDEN CHEMICAL CORPORATION • 393 Seventh Ave., New York 1, N.Y.

CHICAGO • PHILADELPHIA • SAN FRANCISCO • DETROIT • PROVIDENCE

SERVING INDUSTRY THROUGH FINER CHEMICALS

Benzaldehyde • Benzoates • Benzyl Chloride • Bromides
Chlorinated Aromatics • Creosotes • Formaldehyde
Formic Acid • Glycerophosphates • Guaiacols
Hexamethylenetetramine • Medicinal Colloids • Methylene
Salicylic Acid • Paraformaldehyde • Parahydroxybenzoates • Penicillin • Pentaerythritols • Propyl Gallate
Resorcinol • Salicylates • Salicylic Acid • Streptomycin

FINE HEYDEN CHEMICALS

HEYDEN Chemicals

Keep your eye on V·P·I
WHEN SELECTING
BLOWERS

CENTRIFUGAL

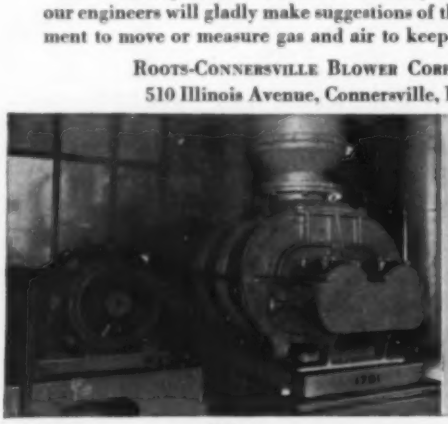
Motor-driven Type OIB Centrifugal Blower in chemical processing plant. Capacity 19,000 cfm.

You can't afford to risk shutdowns today because of unsatisfactory or inadequate equipment performance. To keep production moving at the required fast pace, calls for blowers or gas pumps that continuously deliver positive Volume at required Pressure—and at Low power costs to reduce operating expense.

You get these 3 essentials from R-C Blowers and Gas Pumps. Whether your needs call for Centrifugal or Rotary Positive units, we can match them from our exclusive *dual-ability line*. With capacities from 5 cfm to 100,000 cfm, you can usually find R-C units that closely fit your demands, with resultant savings in time, cost, space, weight and power.

From an experience of almost a century of blower building, our engineers will gladly make suggestions of the right R-C equipment to move or measure gas and air to keep production going.

ROOTS-CONNERSVILLE BLOWER CORPORATION
510 Illinois Avenue, Connersville, Indiana



ROTARY

Rotary Positive Blower for pneumatic conveying in large eastern processing plant. Many other R-C units are used in various plants of this same company.

ROOTS-CONNERSVILLE
BLOWER BUILDERS SINCE 1854
ONE OF THE DRESSER INDUSTRIES

rial, called Industrial Wax W-6119, gives needed protection to many types of food handling equipment, including utensils, stoves, refrigerators, immersion heaters, baking ovens, etc.

It can be applied by conventional dips, spray or brush methods to all types of metals. Vapor degreasing removes it.

Pfizer's $70 million plant for

Improved Vitamin A

Dry, crystalline product. Keeps its potency up to 3 yr. with only 3-4 percent potency loss. Price drop forecast. (204A)

There is nothing especially new about vitamin A. Fish have been synthesizing it for a long time and so have chemists. But now something new has been added by Pfizer to make a better vitamin A, and a cheaper vitamin A.

This first completely dry product will last up to 3 yr. without significant deterioration. The existing vitamin loses 40 percent of its potency in just 3 weeks because oxygen decomposes it.

Older producers like Merck and Hoffman La Roche make the synthetic via the Isler synthesis, then dissolve it in oil to retard oxygen degradation. Pfizer went one step further, successfully coated the crystalline product with gelatine.

Besides the outstanding advantage of extreme stability, the new product is more palatable having no fishy taste or odor; more convenient to handle since it can be tableted; is more versatile, will probably be used to fortify foods, especially for babies and GI's.

Cognizant of its advantage, Pfizer has erected a $7 million plant in

(Continued)

VICTAMIDE (U.S. Pat. 2122122)

Victamide is an ammonium salt of an amido-polyphosphate. It has the following typical analysis:

TYPICAL ANALYSIS

P_2O_5	76.1%
NH_3 (Total)	22.4%
NH_3 (Free)	15.4%
Amide N as NH_3	7.0%

PHYSICAL STATE

Victamide is a white, fluffy, non-crystalline solid. Its particle size is exceedingly fine, practically all being less than 5 microns. The apparent density is only 22 pounds per cubic foot. Victamide has a slightly salty taste and no odor.

SOLUBILITY

Victamide is highly soluble in water (100 grams will dissolve in 100 cc.), going into solution readily in hot water and slowly in cold. A 5% solution has a pH of approximately 5.3. It is slightly soluble in ethylene glycol, but practically insoluble in alcohol, acetic acid, butylacetate, acetone, benzene, toluene, and carbon tetrachloride.

VISCOSITY OF SOLUTIONS

Viscosity increases with concentration up to 25 centipoises at equal parts by weight of Victamide and water. At this concentration the solution has a specific gravity of 1.394.

are you seeking these unique properties?

YOU WILL BENEFIT FROM VICTAMIDE

The unique properties of Victamide offer opportunities for improving your process and increasing the selling advantages of your products. If you would like an experimental sample of Victamide, write today . . . on your company letterhead, please. We shall be glad to work with you.

SEQUESTERING AND WATER SOFTENING

Victamide forms complexes with many metallic ions including calcium, magnesium, copper, aluminum, and iron. Chelation is best accomplished in alkaline solution although this is not essential in every case. A chart showing the amounts of Victamide necessary to soften hard waters is given below. The figures show its effectiveness as a water softener when used with soap.

VICTAMIDE	Hardness of water treated—ppm					
	500	400	300	200	100	50
Room temp. oz. per gal.	.74	.60	.34	.14	.06	.03
140°F oz. per gal.	.44	.28	.20	.12	.06	.02

FLAME RETARDANT PROPERTIES

Victamide is an effective fire retardant. It is preferred in applications where an exceptionally high P_2O_5 content, great solubility, and noncrystalline character are important.

DEFLOCCULATION AND DISPERSION

Victamide's deflocculating and dispersing properties are showing promise in improving the fluidity, pumpability, and solids content of suspensions of kaolin clay, calcium carbonate, and other finely divided solids used in the paper and related industries. These properties also suggest applications in soap and detergent formulations to provide water softening, building, and nondusting characteristics.

VICTOR CHEMICAL WORKS

141 West Jackson Boulevard • Chicago 4, Illinois
A. R. Maas Chemical Co., Division • 4570 Ardine Street, South Gate, California

Pointing the Way... *the NEW WAY in*

CONTINUOUS CHEMICAL FEEDING...

Neptune

CHEMICAL APPORTIONING PUMP

For Boiler Feed-Water Treatment

LEADERS IN INDUSTRY have tested and warmly endorsed this *advanced idea* for the treatment of boiler feed-water.

The new Neptune Pump brings *finer controls* . . . an easy-working simplicity that eliminates costly servicing and delays . . . important "reserve" features that assure uninterrupted pump performance.

NEPTUNE "O" RINGS*

. . . . *heart o' the pump!*

No more leaking packings and scored pistons! The remarkable Neptune "O" Rings assure long and dependable service, new economies in operation and upkeep. An "O" Ring can be changed in 30 seconds . . . saving many hours in pump maintenance.

*Patent Pending

AGENTS

The wide appeal of this new pump is calling for representatives in many areas. Write and we shall send details on a new selling opportunity.

NEPTUNE PUMP MFG. CO.

4912 NORTH 6th STREET

PHILADELPHIA 20 • PENNA.

Groton, hopes eventually to corner 50 percent of the U.S. $12 million market (1949 Pfizer estimate).

The Brooklyn firm makes the vitamin in two forms, has an eye on a third for oleo. Primary form is the powder with 500,000 units/g.; secondary form is a yellow liquid of 1,600,000 units/g.

Non-Melting Waxes

Should be considered wherever waxes are specified for use at elevated temperatures. (206A)

The development of a series of new non-melting waxes has been announced by the Flexrock Co. Even if heated to the combustion point, these waxes will not melt. Such waxes as paraffin, petrolatum, japan wax, beef tallow, beeswax, candelilla, carnauba, ouricuri and others have been specially processed to give them this extraordinary property. Slightly harder than the unprocessed wax, the non-melting waxes have a higher softening point—but they never reach the melting stage. Solubility of the waxes is unaltered.

Moisture Remover

Thoroughly removes moisture from metals, keeps it off with molecular film. (206B)

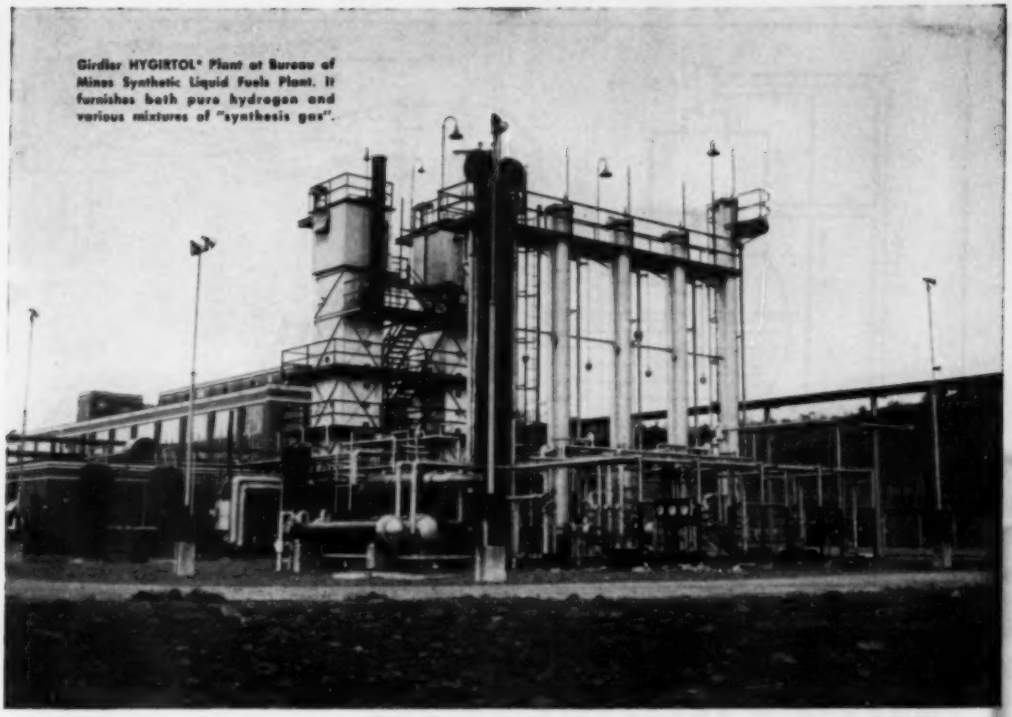
A water-displacing compound developed to insure a chemically moisture-free surface on all metals, has been released by the London Chemical Co.

The liquid called Hydrolift, instantly forms a molecular film which dries in 15 min., can be painted over immediately with good results. The film which forms even in the deepest crevices lifts the moisture to the surface where it runs off. When dry it is transparent and can neither be seen nor felt. Coverage is 8,200 sq. ft. per gal.

According to the company's release, the product is ideally suited as a dip, spray, or brush-on after water rinsing of all metal surfaces—steel, aluminum, zinc, cadmium, chromium, silver, etc., assuring maximum protection of metal surfaces during inter-operational and short term finished product storage. It eliminates the need for water-drying operations, with their attendant water-spotting, oxidizing and hydrating effect on metal surfaces. Hydrolift neutralizes fingerprints and prevents water stains.

After pickling and rinsing, parts immediately dipped in Hydrolift will not rust. There are no "after" reactions, such as darkening the metal, etc.

—*End*



Girdler HYGIRTOL* Plant at Bureau of Mines Synthetic Liquid Fuels Plant. It furnishes both pure hydrogen and various mixtures of "synthesis gas".

Girdler gas plant speeds synthetic fuels process development

ENGINEERS of the U. S. Bureau of Mines believe that the development of processes to produce synthetic liquid fuels will provide a potent wartime ace-in-the-hole.

At the Bureau's plant near Pittsburgh, pilot operations are bringing such processes closer to perfection. Here a Girdler HYGIRTOL* Plant first converts natural gas into hydrogen and "synthesis gas"—a mixture of hydrogen and carbon monoxide. Experiments seek to develop the best process for subsequent conversion of the synthesis gas to liquid hydrocarbons.

In a pilot plant operation such as this, operators must be able to change conditions and gas mixtures frequently. With the HYGIRTOL Plant mixed gas ratios can be varied over a wide range—from 1:1 to 4:1. Although large quantities of gas are produced, mixture ratios can be maintained within 0.2 per cent.

Such control and flexibility simplify experimentation and speed up results. If efficient gas processing is necessary in your operations, let us help you too. The Girdler Corporation, Gas Processes Div., Louisville 1, Kentucky.

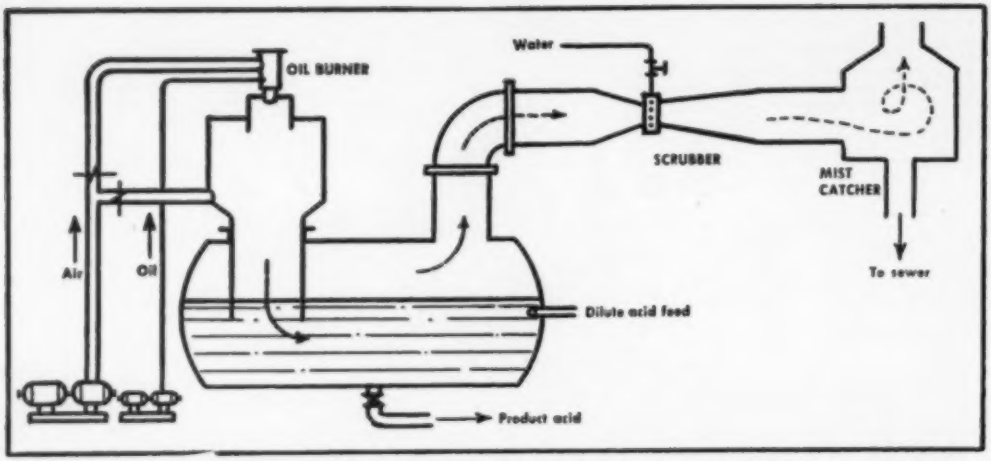
WRITE FOR FREE BOOKLET

It describes Girdler services in designing and building plants to produce, purify or use chemical process gases and plants to purify liquid or gaseous hydrocarbons.

*HYGIRTOL is a trade mark of The Girdler Corporation

THE GIRDLER CORPORATION

Gas Processes Division



Heart of the country's first private continuous triple superphosphate plant is this continuous phosphoric acid concentrator. Acid plan and filter operation run 168 hours per week. Product is bagged 3 hours after rock meets acid.

Continuous Triple Superphosphate

A CHEMICAL ENGINEERING PICTURED FLOWSHEET

Latest triple superphosphate to be built in the United States is in operation at Wendell, Idaho. Gates Bros., Inc., have combined their efforts and resources with the Idaho Farm Bureau Federation to build a phosphoric acid and triple superphosphate plant.

Modifications and improvements have been made in the conventional wet-acid process to reduce manufacturing time, processing losses, and manpower requirements. An administrative, technical, and productive labor staff of 38 men produce 30,000 tons of triple per year.

Phosphate rock containing over 31.5 percent P_2O_5 is brought in from Idaho and Wyoming strip mines by rail. At the plant it is crushed and pulverized to minus 90 mesh in hammer mills equipped with a series of dust collectors. Each pulverizer grinds 6.5 tons per hr. Ground rock is distributed to the acid and triple superphosphate plant by a pneumatic handling closed system.

Automatic weigh belt feeders supply pulverized rock to the series of lead lined digestion tanks where 98 percent sulphuric acid is introduced thru rotometers. A slurry of 28 percent P_2O_5 phosphoric acid and gypsum is pumped to an Oliver horizontal filter (11½ ft. dia.). About 98 percent recovery is made on the phosphoric acid going over the filter.

Chemical Construction Corp. has designed a submerged combustion concentrator that was built in the Gates shops. From 26 to 28 percent P_2O_5 acid is concentrated to 50-52 percent P_2O_5 acid continuously. Fuel oil is used for heating the 2,000 cfm. of air that passes thru the special alloy dip pipe in the concentrator. Fuel efficiencies hit 90 percent. Special acid brick covers the lead-lined steel shell. The unit has a capacity of 60 tons of 50 percent P_2O_5 acid per day. Exit gases pass thru a Pease-Anthony venturi scrubber system and over-all losses are less than 0.5 percent P_2O_5.

Gates Bros. engineers have improved the continuous mixing operation for making triple superphosphate. A redesigned cone mixer adds phosphoric acid to pulverized rock at 130 F. Acid is pumped into the cone through jets at high pressure and a slurry of rock and acid flow by gravity on to a 32-in. moving rubber belt. In 15 min. the triple cures to a consistency which permits disintegration through a series of high-speed blades.

From the disintegrator the wet triple flows into a granulater. This was designed and built by Gates Bros. engineers after a series of pilot studies. The rolling action of the granulater with intermittent water spray rolls the triple into spherical pellets. As the product leaves the granulator it contains approximately 35 percent moisture.

A 60-ft. dryer is heated with 20,000 cfm. of 325 F. air to dry the finished triple. Curing (or completion of the action of the phosphoric acid on the pulverized rock) is completed during drying.

Oversize and fine product is screened out on a vibrating screen. The oversize is ground in a cage mill and returned with the fines to the process belt to form a bed for the acid-rock slurry. Fourteen mesh finished product goes to a 350 ton storage silo, from there to a St. Regis bagger. Pneumatic loading equipment fills rail cars for bulk shipments.

piping upkeep *costs more* now!

Pressure-Seal Bonnet Gate—available in 600, 900, and 1500 pound classes

You spend less for it

by using Dependable Quality

CRANE VALVES

. . . That's why more Crane Valves are used than any other make

NO BONNET JOINT LEAKAGE . . .
NO BONNET JOINT MAINTENANCE

Big maintenance savings can be made on high-pressure/high-temperature piping services by using Crane Pressure-Seal Bonnet valves in place of bolted bonnet valves. Once installed, these valves rarely need maintenance of the bonnet joint—line pressure keeps it leak-tight.

Lighter weight and more compact dimensions make savings in piping erection and suspension. Streamlined body design reduces insulating costs.

Other outstanding and typical features of Crane Pressure-Seal Bonnet Joint design are tailored-to-the-service alloy steels, Stellite trim, deep stuffing box, and flexible wedge disc in larger gates. In gates, globes, angles, or stop-checks, these valves are an investment in better piping performance at lower ultimate cost.

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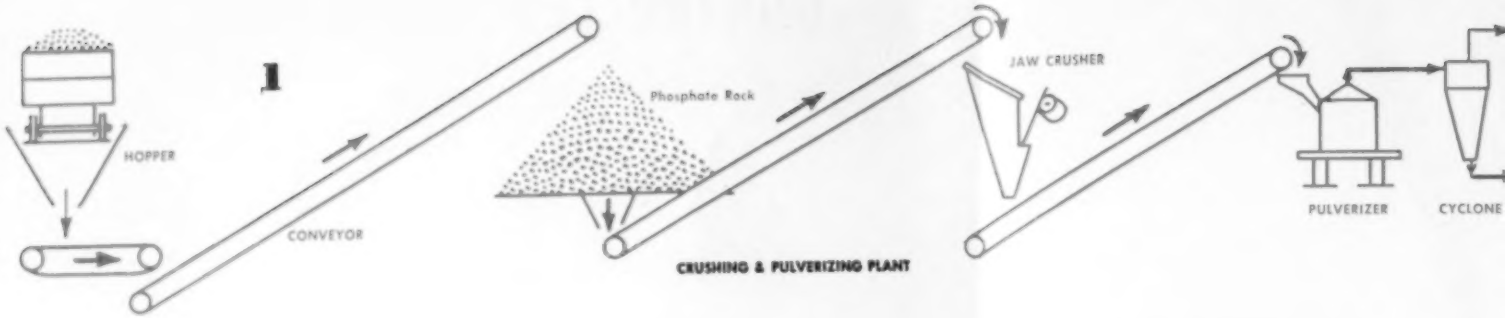
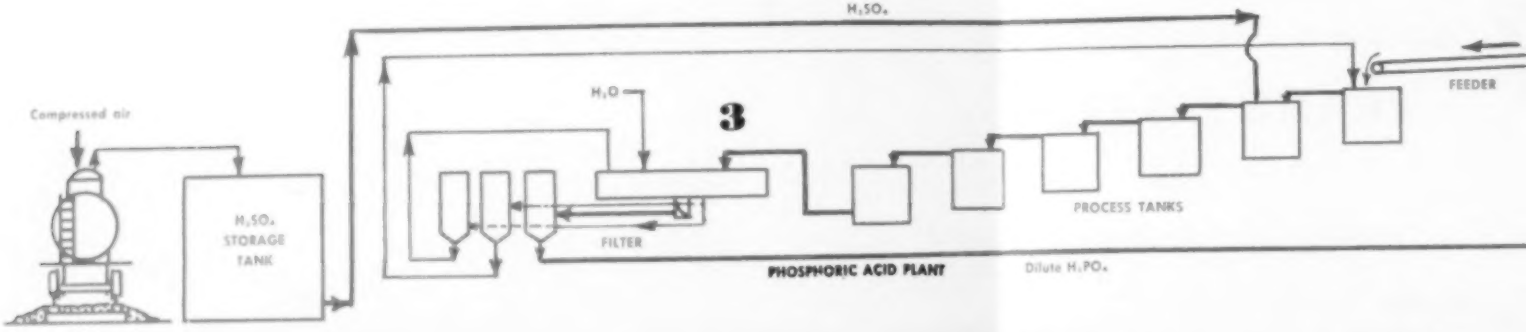
VALVES • FITTINGS • PIPE • PLUMBING • HEATING



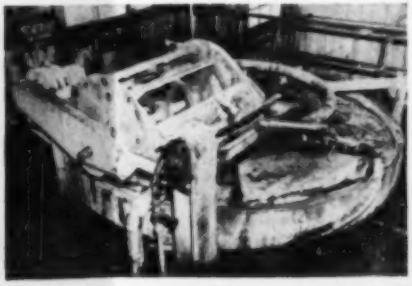
CRUSHING & PULVERIZING PLANT



PHOSPHORIC ACID PLANT

1 Rock is carried from cars, run through a jaw crusher and hammer mill which pulverizes it.

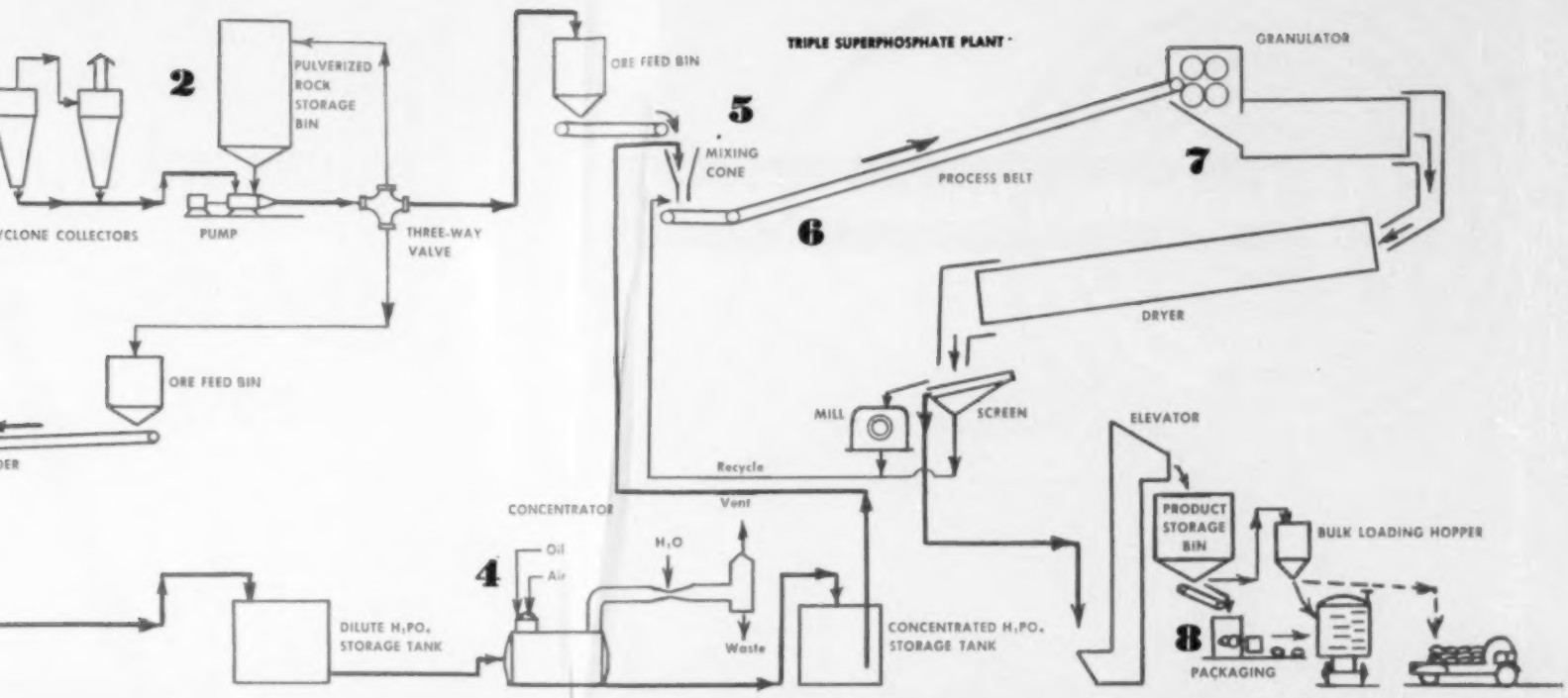
2 Each hammer mill has a dust collector. From them the rock is pumped to feed bins or storage.



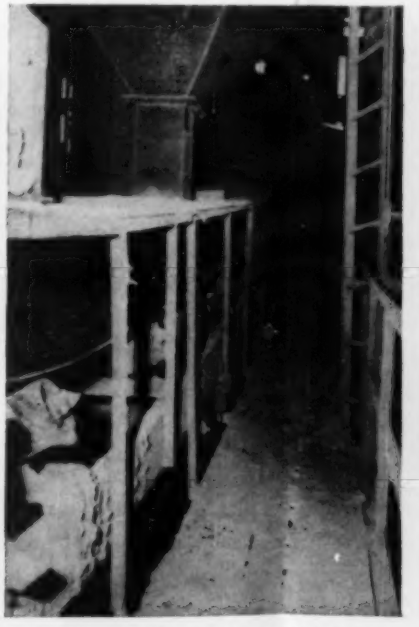
3 This Oliver horizontal filter separates the acid from the gypsum. Dilute acid is stored.

4 Concentrator is continuous submerged combustion unit, doubles acid concentration. See sketch.

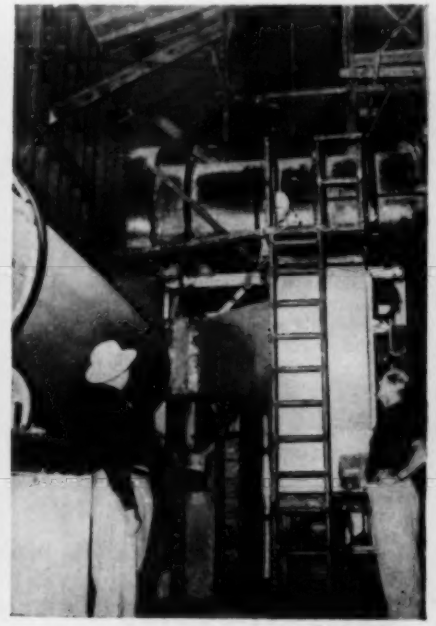
5 Mixing cone, desig phosphoric acid wi



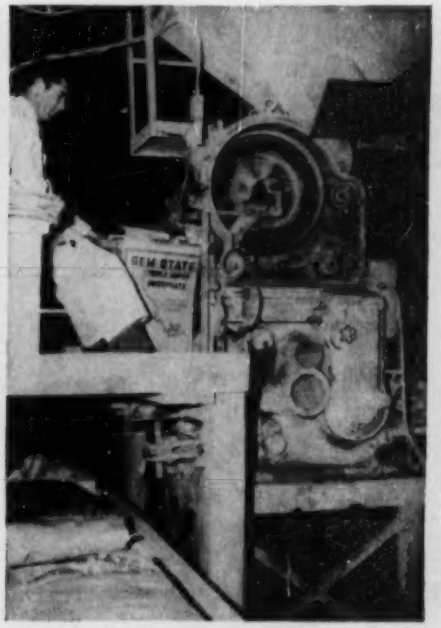
designed by Gates engineers mixes
d with pulverized phosphate rock.



6 Process belt, where acid and rock mixture sets up, cures and is discharged in 15 minutes.



7 Granulator handles all triple superphosphate produced at Gates. Dryer is shown at left.



8 Bagger puts granulated triple in 80-lb. multi-walled plastic-lined bags. Bulk is sold too.

Infinitely Variable Speed

40" Hydraulic Drive Center-Slung Centrifugal illustrated.

. . . MEANS MORE EFFICIENT PROCESSING

In either production or pilot plants, do you have processes that require:

- low speeds for loading . . . high speeds for final extraction?
- washing at some intermediate speed?
- several products with different filtering and washing characteristics to be processed in the same centrifugal?

If so, the *infinitely variable speeds* of Tolhurst Hydraulically Driven Centrifugals will enable you to select the most efficient speed for each of the above processes. Tachometer indicates exact basket speed at all times.

WIDE CHOICE OF MATERIALS

Tolhurst Centrifugal baskets can be perforate or imperforate, constructed of steel, steel rubber-covered, stainless steel, monel or other alloys. Steel case can be lined with stainless steel, monel, rubber or other materials as specified. Machine can be furnished with fume-tight cover, feed and spray pipes.

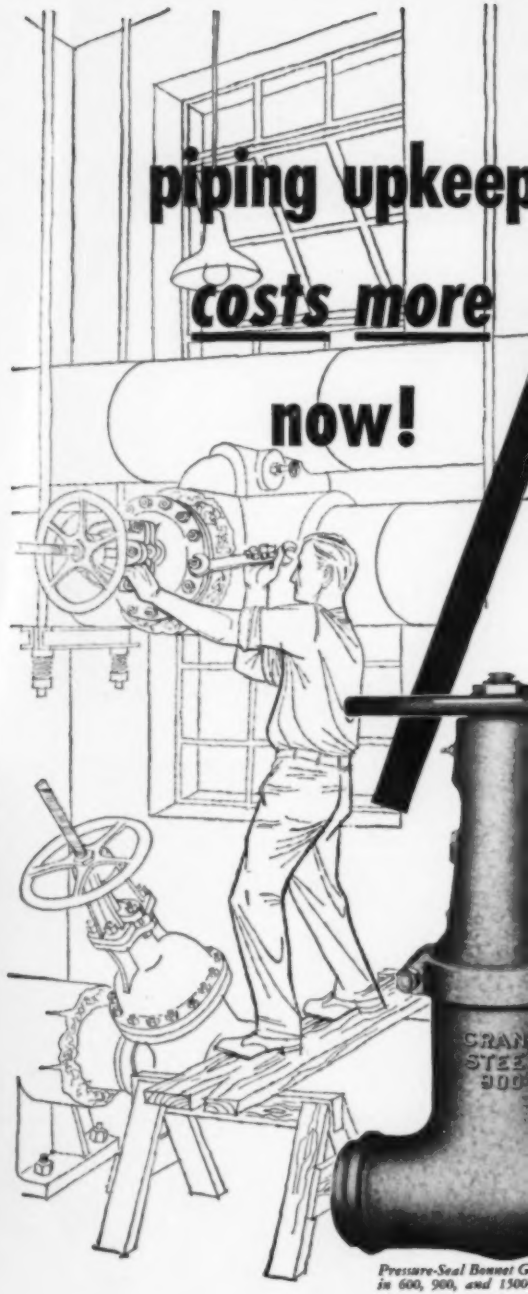
BASKET SIZES AND SPEEDS	
12" diameter 0-3400 RPM	26" diameter 0-1200 RPM
20" diameter 0-1600 RPM	30" diameter 0-1000 RPM
24" diameter 0-1400 RPM	40" diameter 0- 800 RPM
48" diameter 0-750 RPM	

WRITE FOR DETAILS AND PRICES

Tolhurst

CENTRIFUGALS DIVISION
AMERICAN MACHINE AND METALS, INC.
EAST MOLINE, ILLINOIS

piping upkeep *costs more* now!



Pressure-Seal Bonnet G in 600, 900, and 1500

CRANE

VALVES • FITTINGS • PIPE

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You spend less for it

by using Dependable Quality

CRANE VALVES

. . . That's why more Crane Valves are used than any other make

◀ NO BONNET JOINT LEAKAGE . . .
NO BONNET JOINT MAINTENANCE

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...net Gate—available d 1500 pound classes

E

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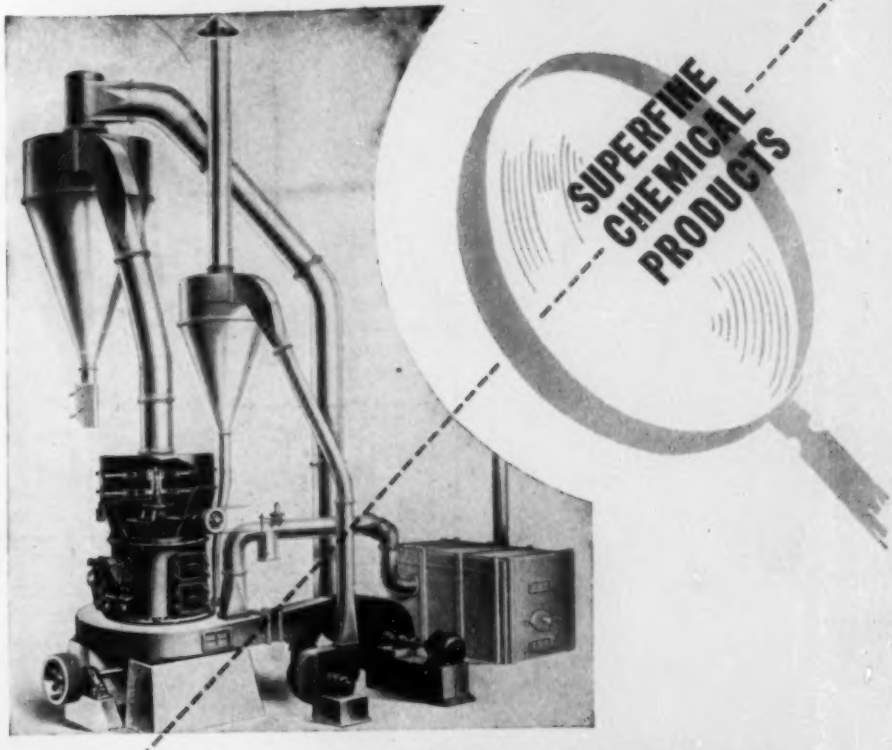
PE • PLUMBING • HEATING

For **CONTROLLED** *Production of*



RAYMOND ROLLER MILL WITH *Flash* DRYING

UNIFORM FINENESS

●

SPECIFIED MOISTURE CONTENT

●

CONSISTENT QUALITY

In this modern automatic equipment, Raymond provides a completely enclosed, dustless system for producing fine grades of many resins, pigments, metallic oxides, non-metallic minerals, and similar materials to meet today's high specifications.

Whizzer separation gives wide range classification up to 99.9% or better passing 325 mesh. Fineness is regulated by one simple adjustment which can be made while the mill is operating.

Flash Drying accessories may be furnished with the equipment for removing surface moisture while pulverizing. This combined operation eliminates extra dryers and conveyors—simplifying production and eliminating re-handling costs.

Pneumatic feed control for maintaining peak efficiencies and capacities . . . automatic throwout for rejecting impurities . . . and close temperature control in the drying operation . . . all contribute to economy of operation and quality of production.

For further details, see Raymond Roller Mill Catalog #61

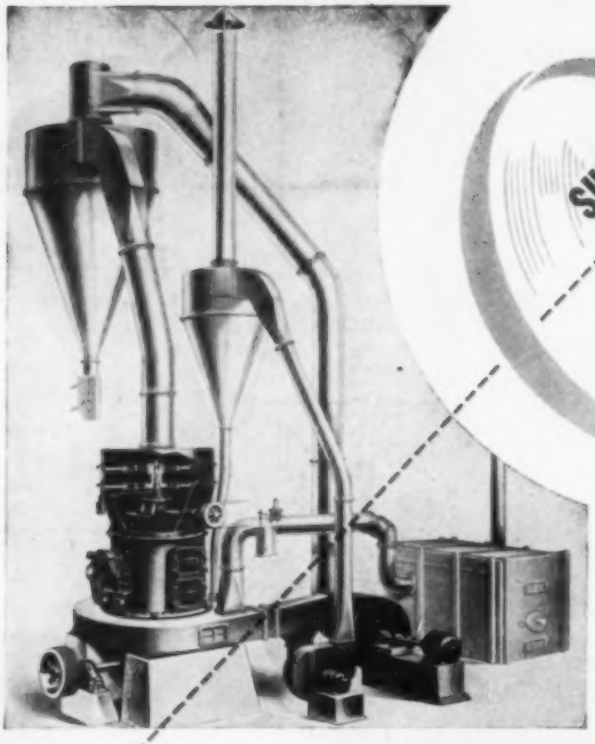
COMBUSTION ENGINEERING-SUPERHEATER, INC.

Sales Offices in Principal Cities

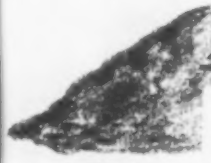
Raymond
PULVERIZER DIVISION

**1311 North Branch St.
Chicago 22, Ill.**

For CONTROLLED *Production of*



SUPERFINE CHEMICAL PRODUCTS



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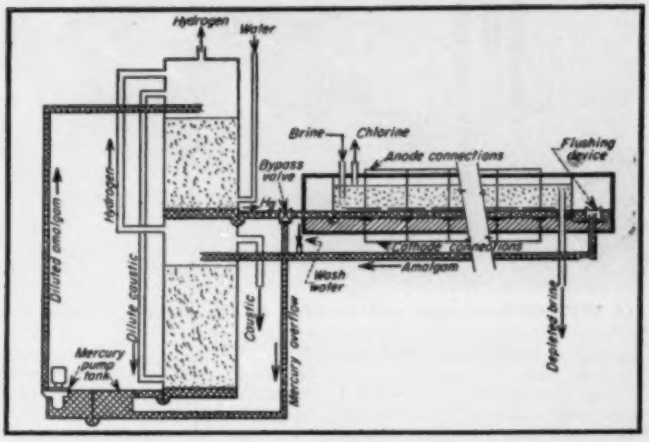
COMBUSTION ENGINEERING-SUPERHEATER, INC.

Sales Offices in Principal Cities

Raymond PULVERIZER DIVISION

1311 North Branch St. Chicago 22, Ill.

OPERATION	
Current	30,000 amp.
Voltage across cell	4.3 v.
Current efficiency	94-96%
Operating temp.	60-75° C.
PRODUCTS	
Chlorine purity	97±2%
Caustic conc.	50-70+ %
Hydrogen purity	99.8±0.2%
PRODUCTION	
Per day at rated capacity.	
Chlorine	2,000 lb.
Caustic	2,256 lb.
Hydrogen (20° C.)	10,000 cu. ft.
CONSUMPTION	
Per short ton of chlorine.	
Power, d.c.	3,100 kwh.
Sodium chloride	3,400-3,600 lb.
Electrodes	7 lb.
Mercury	3-4 oz.
OTHER DATA	
Anode life	11 mo.
Mercury per cell	3,500 lb.



What About the De Nora Cell?

A mercury cell to watch, it's flexible in operation and has high current efficiency.

Today, interest in the De Nora mercury cell is perking up. It's going into new plants for the production of chlorine and caustic. And alert U. S. engineers are watching to see how it stacks up against other mercury cells and whether it is a serious threat to diaphragm cells.

De Nora cells will be installed in the $15 million chlorine-caustic plant being built for the Army Chemical Corps at Muscle Shoals, Ala. They'll also be used in a 25 ton a day chlorine plant under construction at Marathon, Ontario, for Marathon Paper Mills of Canada, Ltd. Monsanto Chemical Co. has the contracts for the design and engineering of these plants; Leonard Construction Co. is building them. Other sales are reported to have been made.

Monsanto has an agreement with Dott. Ing. Oronzio De Nora, Impianti Elettrochimici, the Italian company that developed the cell, for the use and sale of the De Nora amalgam cell in the U. S. and some other countries.

Each 30,000-amp. cell, such as those to be used at Marathon, produces approximately a ton of chlorine daily. Aside from production of pure and vitally needed chlorine, biggest advantage of the cell is its production of rayon-grade caustic at strengths up to 73 percent. But it's flexible in operation, and a wide choice of other products is possible. One method of operation produces chlorine, hydrogen and caustic. Another method, as at Marathon, produces both caustic and sodium sulphide; it can be modified to eliminate caustic and produce only sodium sulphide. The sodium amalgam formed also offers interesting organic reduction possibilities, as well as applications in the metallurgical field.

The paper industry, in particular, is eyeing this versatile cell. Caustic can be obtained, chlorine can be used to make hypochlorites, and sodium sulphide can be produced. In operation, one stage of the decomposer can produce caustic, while the other makes sodium sulphide, or both stages can turn out either caustic or sodium sulphide.

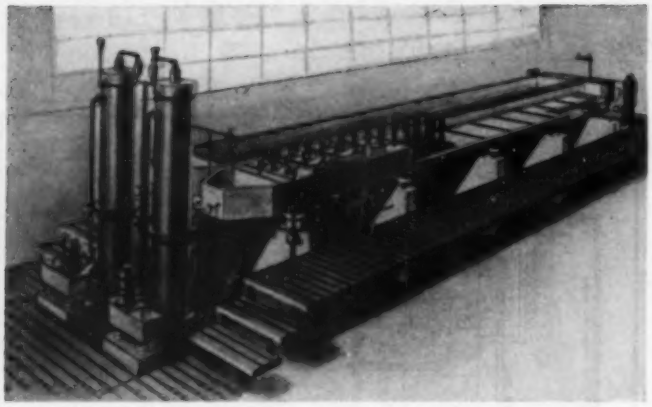
Main advantages of the De Nora cell are its low copper requirements, the lining of bottom as well as sides with a natural stone, and the exclusive two-stage vertical decomposer.

Cells are long steel troughs normally lined with syenite, which is unusually resistant to the conditions encountered in a chlorine cell. The lining is low in first cost, can be repaired or replaced in the field without special facilities, and doesn't require special cleaning when the cells are drained. In addition, it insulates the cell against external temperature variations. The tremendous reduction in area of exposed metal greatly reduces the danger of excessive hydrogen evolution. No auxiliary devices are required for protection against emergencies such as power or mercury pump failures. Because of the nearly complete absence of exposed steel, the cell has a greater tolerance to various impurities that may be present in the feed brine.

Cathode connections for the mercury lie transversely at intervals on the bottom of the trough. The cell normally slopes away from the mercury inlet, and the mercury flows by gravity. Rate of mercury flow through the cell and of amalgam through the decomposer are, in a sense, independent of each other. After passing through the two-stage decomposer, the amalgam, reduced to pure mercury again, is ready for another trip through the cell, where it serves as a moving cathode.

When first starting the cell, graphite anodes are set to within ⅛ in. of the mercury cathode. They have a life of about 11 months.

No special precautions are necessary while starting the cell and brine can be fed cold because of the lined cell bottom and because of decomposer design. Ordinary water can be used in the decomposer, unless highest purity caustic is desired. Caustic purity depends primarily on the purity of the water used, though the product is



DE NORA CELL is compact: needs but 330 sq. ft., with aisles and end spaces.

generally substantially free of chlorates and chlorides.

The decomposer is of compact design, with two stages in a single vertical shell, and guarantees complete decomposition of the amalgam with low mercury loss and with pure products of high concentration. Cleaning, washing and maintenance are rarely needed.

The De Nora cell should dispel any lingering opinion, especially in the United States, that mercury cells are expensive to install and difficult to operate. Certainly the best diaphragm cells were superior to older mercury cells, since they needed less power, used cheap steam and did not require large quantities of expensive mercury, but they did make an inferior caustic. The De Nora cell fits into the picture wherever reasonably cheap electric power is available; it gives high-purity products, and doesn't require an evaporator for concentration of caustic. It's expected to find more applications in the U. S., being used with or even replacing diaphragm cells.

Reynolds Increasing Output Of Aluminum by Expansion

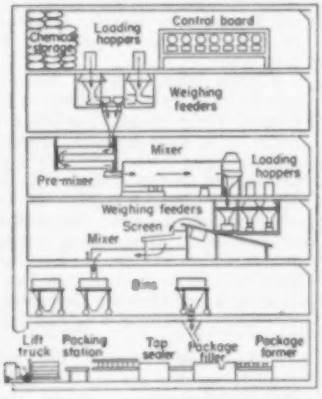
An $80 million aluminum reduction plant is being built for Reynolds Metals Co. near Corpus Christi, Tex. It will have the capacity to produce 150 million pounds of pig aluminum annually. Approximately 600 workers will be employed.

The plant is the result of a request by the National Security Resources Board for Reynolds to increase its aluminum production by 200 million pounds a year. The remainder of the increase will be supplied from an additional potline under construction at the company's Jones Mills plant in Arkansas.

By January 1952 the Texas plant should be in operation. It will be supplied with alumina from the company's Hurricane Creek plant in Arkansas.

One of the reasons Texas was chosen for the plant site is the long-range plan to build an alumina plant adjacent to the reduction plant to utilize bauxite shipped directly from Jamaica. Reynolds Jamaica Mines, Ltd., a wholly owned subsidiary of Reynolds Metals Co., is developing the vast bauxite deposits in Jamaica.

Lloyd A. Amos, formerly reduction plant superintendent at Troutdale, Ore., will be Texas plant manager.



◀ SIXTH FLOOR. Two to five different chemicals required by the formula being mixed go into one of two hoppers. ▶

◀ FIFTH FLOOR. Continuous automatic weighing machines control the rate of flow of each of the chemical ingredients.

◀ FOURTH FLOOR. Chemicals are mixed and blended and loaded into hoppers each of which now holds two or more chemicals.

◀ THIRD FLOOR. Weighing feeders pass ingredients to screen which precedes the final mixing of the recipe's components.

◀ SECOND FLOOR. Portable storage bins hold the finished fixer; samples for the laboratory analysis are taken from them.

◀ FIRST FLOOR. Packaging operations complete the fixer mixing and loaded cartons are trucked to storage or shipped.

Daily Double at Rochester

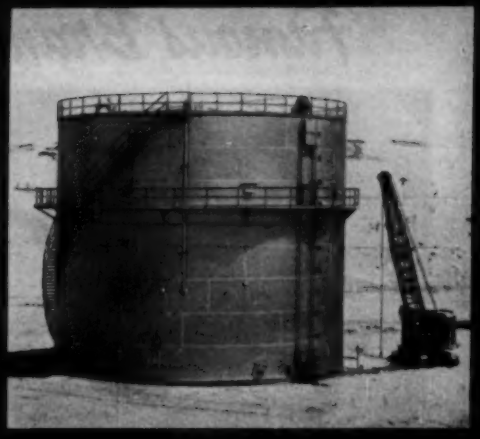
New "fixer mixer" at the Kodak Park plant of Eastman Kodak Co. in Rochester, N. Y., will nearly double their daily output of photographic fixers.

Continuous and automatic, the mixing machine will handle nearly a carload of chemicals a day. It can out-produce old batch methods by more than 30,000 lb. a day. That's an increase of better than 80 percent.

The big mixing installation was designed and built by Kodak engineers. It can be stopped by controls at any point in the operation. A vacuum dust removal system carries away dust.

The stainless steel unit is six stories high. Raw chemicals poured in at the top are thoroughly mixed to specified formula by the time they reach the first floor. Packaged fixers leave the building by truck, usually within a half hour.

Wiggins Gasholder



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How Pfizer Synthesizes Vitamin A

By gelatin-coating pure crystals of vitamin A acetate by a new process, Chas. Pfizer & Co. is producing for the first time synthetic vitamin A in a dry stabilized form. Pfizer makes the vitamin at its new $2 million Groton, Conn., plant.

WHY IT'S IMPORTANT

Despite the sensitivity of vitamin A to oxidation, the new product is so stable that it shows less than 4 percent deterioration when exposed to air at 113 deg. F. for over 1,000 hr. That's roughly equal to a normal shelf life of three years. Natural vitamin A loses 40 percent of its potency in six weeks, according to Pfizer researchers.

The new stabilized vitamin A is the only dry product on the market. Up to now, only soft gelatin capsules have been generally available. The dry form can be used (1) to make tablets, (2) to fortify foods, and (3) to prepare other dry products. Some possible uses: in multivitamin tablets, in military field rations, in milk powders, baby cereals, dog foods and animal feeds.

In the new process, which Pfizer may license, crystals of more than 99 percent purity are coated with gelatin to give a dry stabilized powder with a potency of 500,000 USP units per gram. About 20 percent of this powder is vitamin A, the rest gelatin. The product is practically tasteless and odorless.

Special forms of stabilized synthetic crystalline vitamin A have been developed for use in fortification of oleomargarine. At present, however, the law requires that only natural vitamin A can be used in margarine, each pound of which contains 15,000 units.

Pfizer also makes from the crystalline acetate a liquid vitamin A palmitate with a potency of 1.6 million units per gram. It's unusual in that it contains no oil—just the vitamin, a little palmitic acid, a small amount of oxidized vitamin A resulting from the esterification and an antioxidant.

THE PROCESS

Like Merck & Co. and Hoffmann-La Roche Inc., Pfizer makes vitamin A by the Isler synthesis. Roche controls the Isler process in this country. Another producer, Distillation Products Industries, a division of Eastman Kodak Co., uses a different process. Raw materials in the Isler synthesis are citral from lemon grass, acetone, formaldehyde and acetylene.

FIRST STEP

Citral is condensed with acetone to form the unsaturated ketone pseudoionone; it's isomerized to β-ionone, a ring compound. Glycidation adds one more carbon, changing the β-ionone, to a 14-carbon aldehyde.

Meantime, a 6-carbon side chain is being built up. Acetone and formalde-

(Continued)

CASE HISTORY SERIES

GRINDING OIL-BEARING SEED

Crushing or grinding of oil-bearing seeds—copra, soy beans, cotton seed, peanuts, babassu, palm nuts, flaxseed—(1) ahead of extraction process, and (2) for final grinding of extracted cake to produce uniform meal for feed, is done efficiently by Rietz Disintegrators sometimes in combination with Rietz Prebreakers. As an example, cottonseed handling capacities ahead of presses, exceed 5 tons per hour of raw material.

Write for free technical bulletin on this application.

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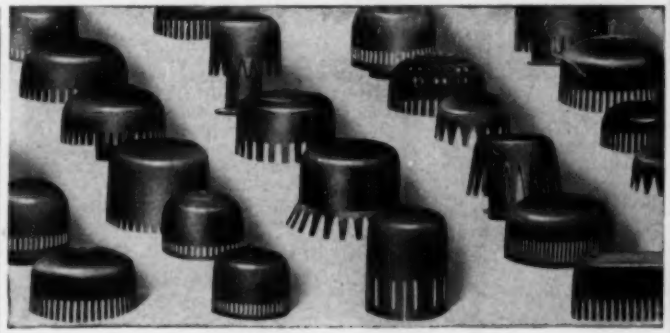

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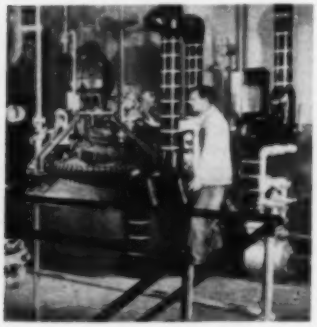
hyde are condensed to methyl vinyl ketone, which then reacts with acetylene under slight pressure. By molecular rearrangement, methyl pentol is formed. A Grignard reaction hooks this 6-carbon pentol to the 14-carbon aldehyde to complete the 20-carbon structure of vitamin A.

Next, the 20-carbon skeleton is selectively hydrogenated, partially acetylated, undergoes an allyl rearrangement, and is dehydrated to form vitamin A acetate. Saponifying the acetate to vitamin A alcohol and esterifying with palmitic gives the vitamin A palmitate.



LAST STEP

Once the basic structure is built up, the compound is sensitive to oxidation; hence final operations take place under a blanket of nitrogen to prevent formation of peroxide linkages, and purification is done under vacuum. The ticklish acetylene reactions call for concave construction to minimize blast effect in the event of an explosion. Glass-lined equipment is used, and the process is automatically controlled.

DEMAND

At full clip, the Groton plant will be able to produce 50 percent of total U. S. civilian and military need for vitamin A. Total domestic demand for vitamin A in 1950 was about 120 trillion units.

In 1949, sales of vitamin A, as bulk material at the manufacturers' level, reached $12 million, Pfizer estimates. Runnerup: vitamin B_{12}, behind by almost $2 million.

Advent of synthetic vitamin A brought the price of the natural vitamin down. Both natural and synthetic now sell for about 18 c. a million units. When first introduced in the U. S., early in 1949, synthetic vitamin A sold for about 55 c. per million units. Most important, synthetic vitamin A minimizes dependence on the

world's fishing fleets for the cod and shark livers from which most of the natural vitamin comes.

All angles of its new patented coating technique are being explored by Pfizer. Waxy emulsifiers and carboxymethyl cellulose are being scrutinized as substitutes for gelatin. Cutting down the gelatin content to get a higher potency product is also being attempted. And Pfizer is eyeing the possibility of coating individual crystals of such compounds as ascorbic, nicotinic and folic acid to prevent their interaction and make them compatible in vitamin preparations.

(Continued)

CONVENTION CALENDAR

American Association of Cereal Chemists, annual meeting, Nicollet Hotel, Minneapolis, Minn., May 21-25.

American Society for Quality Control, fifth national convention, Cleveland Public Auditorium, Cleveland, May 23-24.

Society of the Plastics Industry, Greenbrier Hotel, White Sulphur Springs, W. Va., May 24-25.

Federation of Paint & Varnish Production Clubs, council meeting, Book Cadillac Hotel, Detroit, May 24-25.

Association of Consulting Chemists & Chemical Engineers, outing, Westchester Country Club, Rye, N. Y., May 25.

American Leather Chemists Association, convention, Griswold Hotel, Groton, Conn., June 11-13.

National Fertilizer Association, annual meeting, Greenbrier Hotel, White Sulphur Springs, W. Va., June 11-13.

American Society of Mechanical Engineers, semiannual meeting, Royal York Hotel, Toronto, Canada, June 11-15.

Second Annual Conference on Industrial Research, personnel and communications in research, Columbia University, New York, June 11-15.

American Chemical Society, Division of Organic Chemistry, 12th national organic chemistry symposium, Denver, Colo., June 12-15.

National Society of Professional Engineers, Nicollet Hotel, Minneapolis, Minn., June 13-16.

American Council of Commercial Laboratories, Ambassador Hotel, Los Angeles, June 14-15.

Manufacturing Chemists' Association, joint outing with SOCMA, Greenbrier Hotel, White Sulphur Springs, W. Va., June 14-16.

Synthetic Organic Chemical Manufacturers Association, joint outing with MCA, Greenbrier Hotel, White Sulphur Springs, W. Va., June 14-16.

American Plant Food Council, annual meeting, The Homestead, Hot Springs, Va., June 14-17.

Chemical Institute of Canada, annual conference, Winnipeg, June 18-20.

American Society for Testing Materials, annual meeting, Atlantic City, N. J., June 18-22.

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Novel Tower, Injection Feed Improve Phosphate Process

Two novel engineering features are embodied in the new TVA demonstration plant at Wilson Dam, which produces calcium metaphosphate fertilizer. In essence, this is still the process: liquid phosphorus is burned in a horizontal combustion chamber and the resulting P_2O_5 reacted with rock phosphate to produce the calcium metaphosphate. But there've been major improvements.

First innovation is a new design that eliminates the grate formerly used to support the lump phosphate charge, substitutes for it a big steel elbow (see cut) at the bottom of the absorption tower. When an elevated water-cooled grate was used it frequently failed to hold the charge up.

Now the lump phosphate charge is supported by a 90-deg. steel elbow, close to 5 ft. in diameter. It forms the bottom of a vertical bosh absorption tower. A horizontal duct connects the elbow to the phosphorus combustion chamber. Elbow, bosh section and duct are lined with zircon brick; the upper part of the tower is lined with firebrick. Water cools the outside of the tower, the steel supporting elbow and the top of the cylindrical duct.

Second change is a new method of operation in which finely ground phosphate is injected into the combustion chamber, where it reacts with most of the P_2O_5 to form calcium metaphosphate; unreacted oxide from the chamber reacts with the lump charge in the absorption tower to produce more metaphosphate. Formerly no fines were injected into the chamber, and the P_2O_5 reacted only with the lump charge in the tower. This direct injection of fines increases production capacity and improves control

of the P_2O_5/CaO ratio in the product.

With this new fines feed method, it's possible to keep the P_2O_5/CaO ratio within the optimum 0.95-1.00 range by adjusting the feed rate. Injection of fine phosphate directly into the chamber also allows phosphorus burning rates as high as 2,000 lb. per hr. and cuts P_2O_5 loss in the waste gas. Fine phosphate feed supplies 69 percent of the total phosphatic raw material; the rest is lump charged to the absorption tower.

Other novel features: an internally water-cooled rotary drum flaker for cooling the molten product, and a water spray inside the combustion chamber to control the temperature, keeping it around 2,000 deg. F. Currently the TVA plant (to be described in detail soon in *Chem. Eng.*) turns out about 115 tons a day of calcium metaphosphate, containing 60 to 65 percent available P_2O_5.

Uranium Ore Refinery Will Make Feeds for Atom Plants

A uranium ore refinery and other facilities for the production of uranium feed materials will be constructed for the U. S. Atomic Energy Commission on a 1,200-acre site 19 miles northwest of downtown Cincinnati, Ohio. Uranium ore will be refined and processed into forms suitable for use at the AEC's fissionable materials production plants. No atomic weapons will be made at the new installation and operations there will present no radiological or toxic hazards to the area.

After the ore, once obtained, has been dried, crushed and weighed, it goes to specially equipped plants for conversion into brown oxide (UO_4) and simultaneous removal of impurities.

Next step, also a complicated one, converts the brown oxide into green salt (UF_4). At this point the path branches, depending upon whether the material is destined for Hanford plutonium piles or Oak Ridge separation plants.

In one instance, the green salt must be reduced to metal billets, another industrial project of complexity; and the billets are then processed into slugs of suitable size and shape for insertion into the Hanford reactors.

If Oak Ridge is the terminal point, however, material in the green salt stage is converted, again through special and large-scale plants, into uranium hexafluoride.

This feeding operation engages an entire specialized segment of the nation's chemical industry.

The new ore refinery and other

(Continued)

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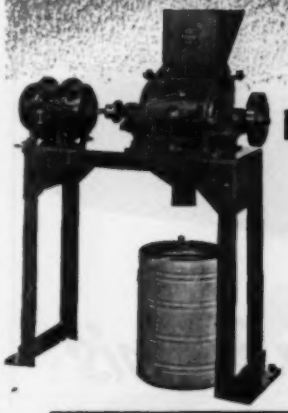

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processing facilities, estimated to cost at least $30 million, are being designed by the Catalytic Construction Co. The installation will require a permanent working force of about 1,200; it will be administered by the Fernald Area of AEC's New York Operations Office.

Open Hearth Slag Source Of Vital Manganese

A miniature blast furnace at Pittsburgh, Pa., is being operated in an attempt to recover the manganese in slag from open hearth furnaces. The 16-ft. high furnace only recently started operating. Project is sponsored by steel companies through the American Iron & Steel Institute.

Research on manganese, an essential element in steel making, has been intensive in recent months to avert possible U. S. shortage if foreign sources of supply are drastically reduced. Some research metallurgists believe that an estimated 440,000 tons a year of manganese may be found in this country in economically recoverable open hearth slag. That tonnage is equal to approximately 68 percent of the amount used in steel manufacturing during 1950.

The small blast furnace is intended to simulate conditions in a commercial structure in attempts to remove undesirables, such as phosphorus, from the open hearth slag. If the theory being tested at Pittsburgh proves practical, a useful ferroalloy containing 80 percent manganese will be produced.

Other methods of recovering manganese from slag are being studied at College Park, Md., and still a third project sponsored by the steel companies through the American Iron & Steel Institute may soon be undertaken.

Chlorine-Caustic Plant To Employ Mercury Cells

A new chlorine and caustic soda plant will be erected by Blaw-Knox Co. for Mathieson Alabama Chemical Corp. at McIntosh, Ala., on the Tombigbee River, north of Mobile.

The plant will use the Mathieson mercury cell process, which produces high-purity chlorine and caustic soda of rayon grade. Salt will come from the nearby McIntosh Dome.

With demand for chlorine and caustic growing, Blaw-Knox has been authorized to build plants for licensees using the Mathieson high-capacity mercury cell process.

(Continued)

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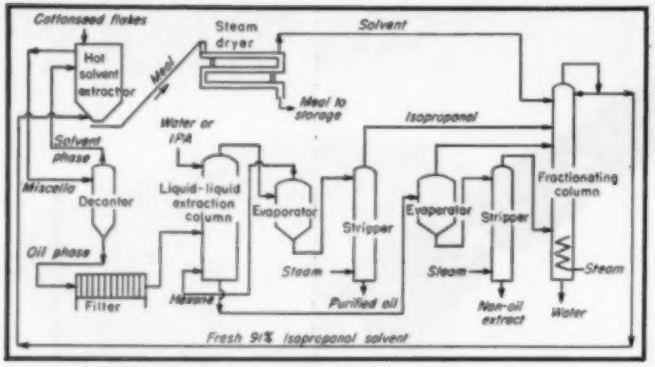


New Extraction Process

An improved solvent extraction process has now been made available to the cottonseed industry by the Texas Engineering Experiment Station and the Cotton Research Committee of Texas. Research was done by Dr. W. D. Harris, professor of chemical engineering at Texas A. & M.

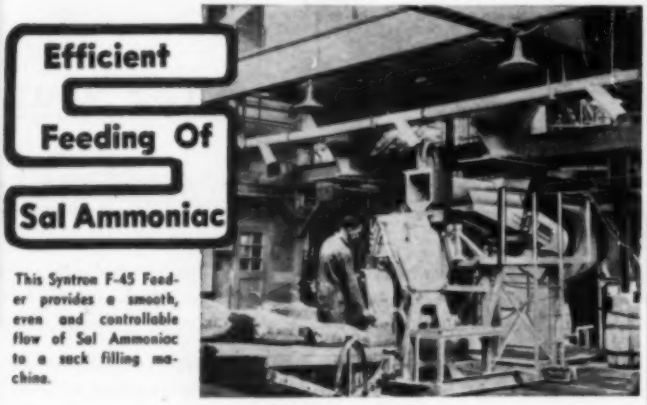
Isopropanol is used to extract the cottonseed oil, gossypol and other substances from cottonseed meats. Liquid-liquid extraction separates a high-grade oil from impurities in the miscella. Isopropanol is used as the solvent because of its (1) low fire hazard; (2) ability to extract the toxic substances; (3) miscibility with both oil and water.

The new process gives: (1) an oil of uniform quality regardless of seed quality; (2) a higher yield of refined oil than other processes, including extraction with hexane; (3) a meal higher in nutritional value than those from hydraulic, screw-press or hexane extraction methods.

A commercial process, as now projected from research work, is shown in the flow diagram. Cottonseed flakes are treated in the continuous, countercurrent extractor with hot, 91 percent isopropanol. The extract is cooled to separate oil from the solvent phase, which is recycled through the rich end of the extractor.

Oil product and surplus solvent phase are filtered and fed into the center of a liquid-liquid extraction column. Hexane rises through the column and strips the non-oil matter from the rising hexane-oil phase. Hexane is removed from the purified oil by evaporation and stripping; it is condensed for re-use.

The isopropanol phase from the extraction column is also evaporated; vapors are fed directly into a fractionating column for concentration to 91 percent.



Efficient Feeding Of Sal Ammoniac

This Syntron F-45 Feeder provides a smooth, even and controllable flow of Sal Ammoniac to a sack filling machine.

SYNTRON

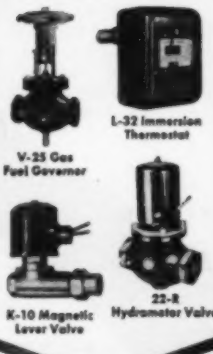
VIBRATORY FEEDERS

WILL HANDLE most all types of bulk materials—fine, abrasive, lumpy, hot, cold, dry, damp. AT variably controlled rates from pounds to hundreds of tons per hour. TO mixers, driers, ovens, crushers, belts, screens, packaging and bagging machines, etc. WITH very low maintenance costs due to absence of motors, pulleys, eccentrics, cams, gears and other wearing parts.

Write To—

SYNTRON COMPANY
810 Lexington Avenue Homer City Penna.

1st choice for AUTOMATIC CONTROL



V-25 Gas Fuel Governor
L-32 Immersion Thermostat
K-10 Magnetic Lever Valve
22-R Hydrumator Valve

GENERAL CONTROLS

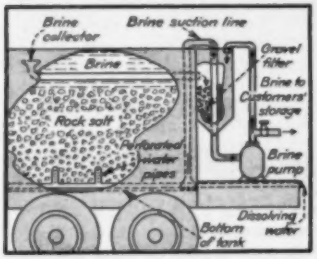
Manufacturers of Automatic Pressure, Temperature, Level and Flow Controls

FACTORY BRANCHES: Baltimore 5, Birmingham 3, Boston 16, Buffalo 3, Chicago 5, Cincinnati 2, Cleveland 15, Dallas 2, Denver 4, Detroit 21, Glendale 1, Houston 6, Indianapolis 5, Kansas City 2, Minneapolis 2, Newark 6, New York 17, Philadelphia 23, Pittsburgh 22, St. Louis 3, San Francisco 7, Seattle 1, Tulsa 6, Washington 6.
DISTRIBUTORS IN PRINCIPAL CITIES

The non-oil extract is recovered free of solvent. It may be sold as crude fatty acids or—by using a second hexane liquid-liquid extraction—as purified acids.

Meal from the extractor is freed of solvent in a conventional steam-heated meal dryer. Solvent vapors are fed into the fractionating column for concentration.

An azeotropic distillation column (if justified by economics) would raise IPA to 93 percent and improve the oil extraction. Use of a reflux in place of hexane in the extraction column for concentrating the non-oil matter would simplify the process; a small amount of oil would then be left in the non-oil material.



Portable Brine Maker Hauls Rock Salt to Texas Plants

Something new in service is now available to chemical processing firms in the Houston area: salt—as crushed rock or brine—delivered by truck right to the consuming plant. The service covers a radius of 250 miles from Houston. Deliveries are made around the clock, often within an hour after receipt.

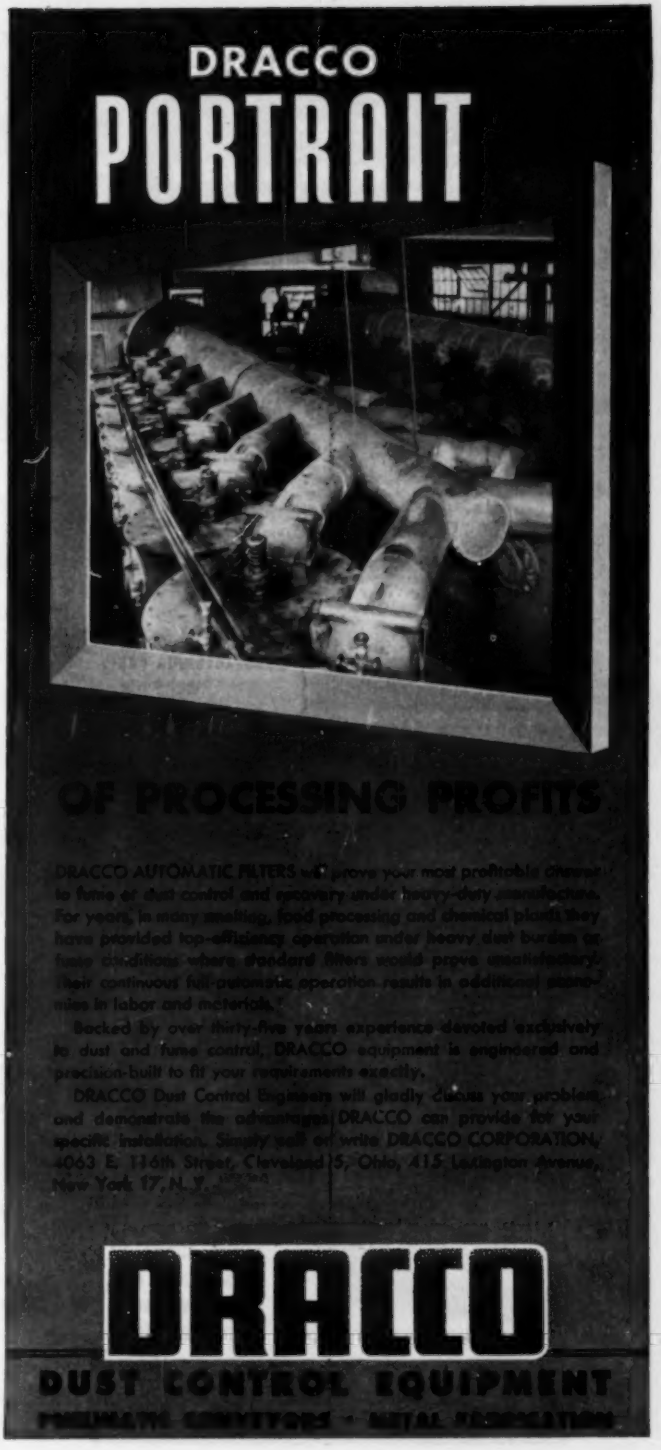
Firm that started this unique service is Texas Brine Corp. at Houston. Salt is supplied by United Salt Corp., an affiliate. Brine comes from a dome five miles from Houston, rock salt from nearby Hockley. Customers include paper mills, synthetic rubber plants, electrolytic caustic units, water-softening plants, oil companies, ice and refrigeration plants. Cost of both brine and rock to the customer is on the basis of salt content.

Saturated brine is delivered in the Houston area by trailer tank trucks with a capacity of 2,000-4,000 gal. of brine (5,300-10,600 lb. of salt).

If the customer prefers rock salt—or is located beyond the economic point to which brine can be transported—delivery is made by special-design trailer trucks with a maximum capacity of 20 tons of salt. These are actually "converters" or portable brine makers.

Each converter has a dissolving

(Continued)


DRACCO
PORTRAIT
OF PROCESSING PROFITS
DRACCO AUTOMATIC FILTERS will prove your most profitable chemist in fume or dust control and recovery under heavy-duty manufacture. For years, in many smelting, food processing and chemical plants they have provided top-efficiency operation under heavy dust burden or fume conditions where standard filters would prove unsatisfactory. Their continuous full-automatic operation results in additional economies in labor and materials.
Backed by over thirty-five years experience devoted exclusively to dust and fume control, DRACCO equipment is engineered and precision-built to fit your requirements exactly.
DRACCO Dust Control Engineers will gladly discuss your problem and demonstrate the advantages DRACCO can provide for your specific installation. Simply call or write DRACCO CORPORATION, 4063 E. 116th Street, Cleveland 5, Ohio, 415 Lexington Avenue, New York 17, N. Y.
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DUST CONTROL EQUIPMENT
PNEUMATIC CONVEYORS · METAL FABRICATION

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Everywhere
water heater
manufacturer
specifies
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Type "RH-TL" Revolving
Hood Relief Valve
Convinced of CASH-ACME Automatic Valve quality and consistent performance under pressure, one of the largest manufacturers of automatic hot water heaters installs this better relief valve on all their products. It protects them, it protects their customers when CASH-ACME is on the job. Let us tell you about the growing number of industries depending on CASH-ACME. Write for literature describing the part CASH-ACME Automatic Valves can play in the successful operation of your products.
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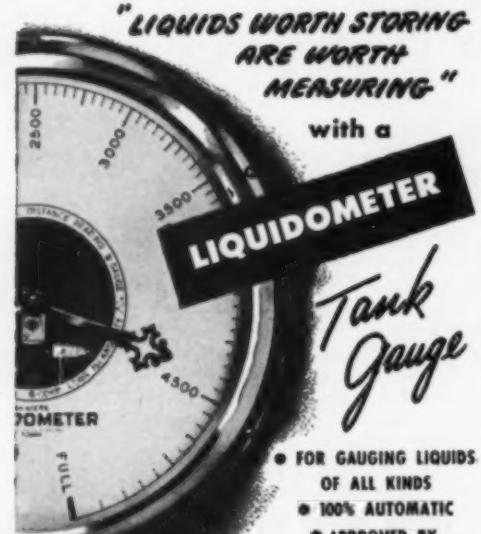


tank, brine filter chamber, pumps and piping and is mounted on a tandem trailer. Construction is mayari iron coated on the inside with a bitumastic lining for protection against corrosion and abrasion.

Rock salt is converted into brine at the customer's plant by connecting a water line to the dissolver. Water enters under pressure near the bottom of the front end, feeds into a series of smaller perforated pipes, then flows upward through the salt. Valves equalize the flow and distribute the water along the converter bottom.

As the brine leaves the converter it passes through a sand-gravel filter at the rear of the truck and is pumped through a rubber hose to the consumer's storage tank. Conversion rate is 5.5 tons of salt—close to 4,000 gal. of saturated brine—per hour. The product has a small amount of soluble calcium salts as impurity.

AEC Picks Dow to Run New Secret Operation

On a 4-sq.-mi.-site in the Rocky Flats area of Boulder and Jefferson Counties near Denver, Colo., a new production plant will be built for the U. S. Atomic Energy Commission. Estimated cost of the facility, a secret type of operation, is $45 million. It will be administered by AEC's Santa Fe Operations Office, which is responsible for research, development, production and testing of atomic weapons.

Dow Chemical Co. will operate the plant and has assisted in establishing production requirements and site criteria. It is expected 1,000 persons will be employed when full operations commence. F. H. Langell will be Dow's plant manager.

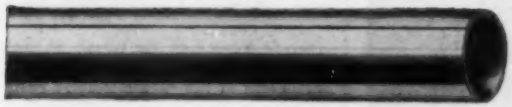
Officials of Dow in Midland, Mich., state that the company did not seek this assignment, but was asked to undertake it because of scientific and manufacturing experience along lines that bear on the project. In addition to Langell, Dr. L. A. Matheson of Dow's physical research laboratory will be assigned to the project as technical director, together with other key personnel required.

Austin Co. of Cleveland, Ohio, will prepare the plant design and supervise construction. Austin conducted the site survey and engineering investigations for AEC. Construction is just getting under way; about 2,000 workers will swarm over the site during the peak of building in early 1952.

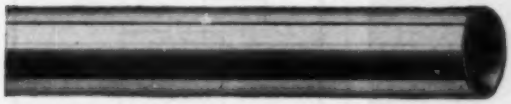
The new production plant will handle radioactive material. The opera-

(Continued)

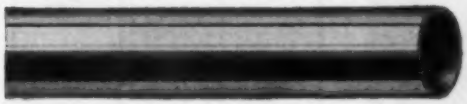
RESISTANCE TO CORROSION



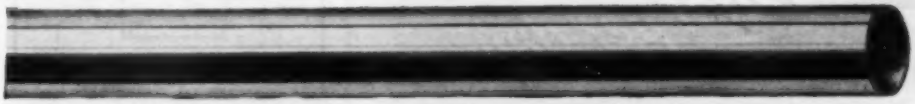
STRENGTH AT HIGH TEMPERATURES



RESISTANCE TO OXIDATION



EASE OF FABRICATION



What's Your Job For Stainless Steel Tubing? . . .

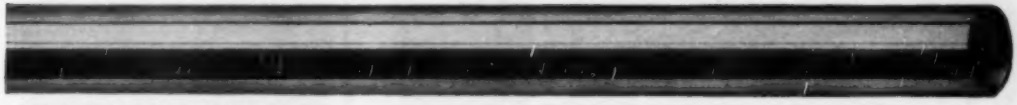
Do The Job Best With The Best Tubing For The Job – Get

GLOBE

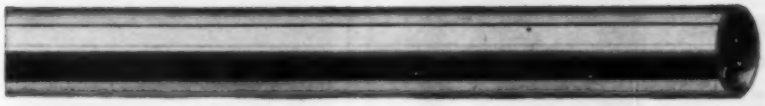
STAINLESS STEEL TUBES
Seamless or Welded

TYPICAL ANALYSES: 301 - 302 - 302B - 304 - 308 - 309 - 309S - 309Cb - 310 - 314 - 316 316Cb - 317 - 321 - 329 - 330 - 347 - 403 - 405 - 410 - 416 - 430 - 443 - 446 Inconel* Nichrome**

*Registered U. S. Trade-Mark. **Trade-Mark Reg. U. S. Pat. Off.-D-H Co.



SEAMLESS OR WELDED



GLOBE TUBES

GLOBE SEAMLESS STAINLESS STEEL TUBES

GLOWELD WELDED STAINLESS STEEL TUBES

Globe produces 26 standard analyses of stainless steel tubes — also special analyses when required.

Globe seamless stainless steel tubing may be had in sizes from ½ inch to 6⅝ inches O.D., and in pipe sizes ⅛ inch to 6 inches, standard, extra strong and double extra strong weights.

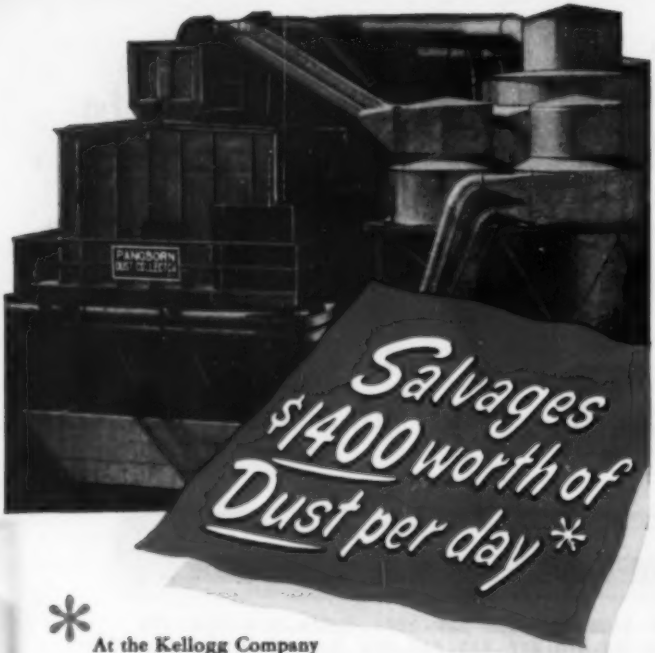
Gloweld electric welded stainless steel tubing may be had in sizes ranging from ¼ inch to 5 inches O.D. inclusive; in standard weight pipe (schedule 40) sizes ⅛ inch to 2 inches — in light weld pipe (schedule 40) sizes ⅛ inch to 4½ inches inclusive.

Globe engineers gladly give you the benefit of specialized knowledge of stainless steel tubing in a wide range of services and applications — to improve your product — to cut costs.

GLOBE STEEL TUBES CO., Milwaukee 46, Wis.

Chicago • Cleveland • Detroit • New York • Philadelphia
St. Louis • Houston • Denver • San Francisco • Glendale, Cal.

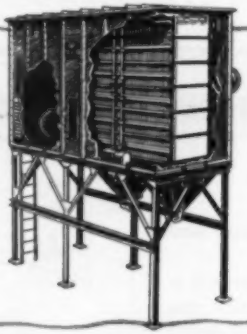
Write for Bulletin 301 — Corrosion and Heat Resisting Steel Analyses Chart — a valuable reference tabulation of stainless steel analyses as produced by various manufacturers.



* At the Kellogg Company of Battle Creek, Mich., this Pangborn Dust Control system salvages 35 tons of valuable dust per day. Collected from the corn mill and the Gro-Pup building, the dust is valued at $40 a ton . . . building a profit of *$1400 a day* for Kellogg!

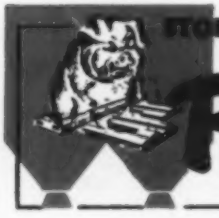
Here's how Pangborn makes Dust Control *profitable* for industry!

Pangborn Dust Collectors make low-cost dust control possible. As this cutaway shows, type "CH" Collectors are compact, offer maximum filtering area in a given size. Filter life is prolonged because dust-laden air passes through collector at low velocity. Efficiency is extremely high; in fact, clean exhausted air can often be returned direct to plant.



FIND OUT how Pangborn Dust Control *turns dust into profits.* Write for a copy of Bulletin 909A to: PANGBORN CORPORATION, 2600 Pangborn Blvd., Hagerstown, Maryland.

Look to Pangborn for the latest developments in Dust Control and Blast Cleaning Equipment

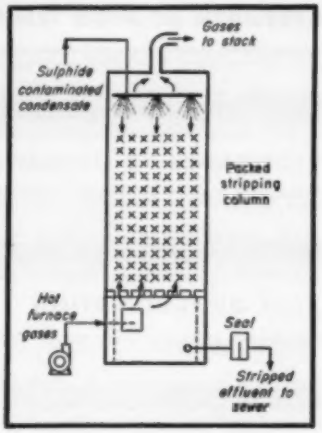


STOP THE DUST HOG from stealing profits with

Pangborn

DUST CONTROL

tion will have only moderate water, gas and electric requirements. No further description of the nature of the operation is permitted under security provisions of the Atomic Energy Act.



Bergström Tower Removes Sulphides and Mercaptans

Second Bergström tower to be built in the United States is now going into operation at the new kraft pulp mill of Potlatch Forests, Inc., near Lewiston, Idaho. The unit is designed to remove sulphides and mercaptans—particularly harmful to fish life—from condensates of kraft pulping operations. The country's first Bergström unit was installed last year at Weyerhaeuser Timber's new kraft mill at Springfield, Ore.

Principle of the Bergström tower is simple (see cut). Evaporator, digester and other condensates containing alkaline sulphides and mercaptans are sprayed into the top of a wooden tower packed with tile rings. Hot furnace gases at about 275-300 deg. F. are blown in at the bottom.

Carbon dioxide in the furnace gases reacts with the fixed sulphides and mercaptans to form H_2S and CH_3SH, which are stripped out by the gases. The CO_2 lowers the pH and forms harmless sodium carbonate and bicarbonate, which remain in the effluent sent to the sewer. Byproduct lime sludge reduces foaming in the tower.

Efficiency of the tower is 75-85 percent for removing sulphides and 60-70 percent for stripping out mercaptans from kraft mill condensates. This can be raised by using larger volumes of stripping gases. The process is licensed under U. S. Patent 2,282,112 issued to H.O.V. Bergström and K. G. Trobeck of Stockholm.

USI Builds Allethrin Plant At Baltimore Location

U. S. Industrial Chemicals, Inc., will build a plant for the production of allethrin, a chemical with some of the properties of natural pyrethrum, oldest of all insecticides. The plant will be located on the company's Baltimore, Md., property. It's expected to be completed late in 1952.

Production of the chemical will aid materially in filling the needs of the defense effort for adequate supplies of insecticide materials, especially since pyrethrum has been in short supply.

USI has received a certificate for rapid amortization at 50 percent of the $840,000 estimated cost of the allethrin plant.

Allethrin is a synthetic that corresponds closely to one of the important constituents of pyrethrum; it possesses some of the advantages of the natural product. The U. S. Department of Agriculture first synthesized allethrin in 1949.

Glass Fibers Keep Strength When Sized With Silane

A new sizing technique now promises to increase mechanical strength of reinforced plastic laminations of glass fiber and polyester resins. Water or high humidity reduces flexural strength of these by close to 50 percent, much to the regret of the Air Force and other users of the reinforced laminates.

Now, by applying a vinyltrichlorosilane size to glass fiber, the laminate can be made to retain over 90 percent of its flexural strength even after three hours in boiling water. So reports Luther L. Yaeger (see cut) of Bjorksten Research Laboratories, Madison, Wis.

(Continued)

Here's how Pangborn

Solves these Problems

with this modern equipment

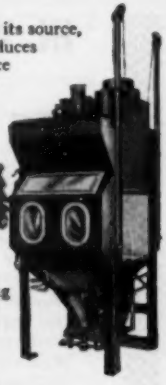
BLAST CLEANING!

Blast Cleaning Cabinet quickly and easily cleans rust, grime, dirt, paint, etc., from metal parts. Produces a clean, smooth surface on pieces up to 60" x 36". Models available from $315.00 and up.

Blast Cleaning Machine not only removes rust, dirt, scale, etc., but is ideal for maintenance and many other uses. Cleans large objects such as bridges, structural work, tanks before painting. Six sizes, portable or stationary, from $170.00 and up.

DUST COLLECTING!

Unit Dust Collector stops dust at its source, minimizes machine wear and tear, reduces housekeeping and general maintenance costs. Solves many grinding and polishing nuisances. Reduces material losses. Models from $286.00 and up.



PRECISION FINISHING!

Hydro-Finish Cabinet uses liquid blast, eliminating dust, and reduces costly hand polishing, cleaning and finishing of molds, dies, tools, etc. Removes scale, discoloration and directional grinding lines, prepares surfaces for plating and coating. Holds tolerances to .0001". Models from $1295.00 and up.

LOOK TO PANGBORN FOR THE LATEST DEVELOPMENTS IN BLAST CLEANING AND DUST CONTROL EQUIPMENT

Pangborn

MAIL COUPON for full details

(Check for more information)

- ☐ Blast Cleaning Cabinets
- ☐ Blast Cleaning Machines
- ☐ Unit Dust Collectors
- ☐ Hydro-Finish Cabinets

PANGBORN CORP., 2600 Pangborn Blvd., Hagerstown, Md.

Gentlemen: Please send me more information on the equipment I've checked at the left.

Name.....

Company.....

Address.....

City.....Zone.....State.....

FOR LOWER STORAGE COSTS

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Kalamazoo

GLAZED TILE

You practically eliminate maintenance problems and costs when you store bulk materials such as chemicals, coal, ashes, sand, gravel, cement, clay, grain, fertilizers, etc., in tanks and silos made of Kalamazoo Glazed Tile. Far superior to concrete—easy to clean—cannot contaminate contents. For a *permanent* low-cost installation, specify Kalamazoo Glazed Tile.

Kalamazoo TANK AND SILO COMPANY

539 HARRISON ST. KALAMAZOO, MICHIGAN

IN WIRE-MESH PRODUCTS LET JELLIFF DO IT!

For 70 years we've been weaving Wire Mesh. And a good part of that time we have also been making things of Wire Mesh for people who find it is cheaper, easier and generally more satisfactory to "let Jelliff do it."

From big Dipping Baskets to tiny precision filters—from fuel stainers to what-is-it gadgets—JELLIFF's Custom Production Department turns out fabricated Wire-Mesh products at speed, price and precision that mean lower costs and a stronger competitive position for our many customers.

If you buy or make wire-mesh assemblies as components of your own products and have not yet had an estimate from Jelliff, write today for details. No obligation, even if you enclose a blueprint for us to figure on. Address Department 15.

THE C. O. JELLIFF MFG. CORP.

DIPPING BASKETS · LEKTROMESH · RESISTANCE WIRE

WIRE MESH PARTS · WIRE CLOTH · STRAINERS · FILTERS

SOUTHPORT CONNECTICUT

Vinyltrichlorosilane is applied either in vapor phase or as a solution in an organic solvent. After drying, the glass fiber is washed with water. This is believed to hydrolyze off the chlorine so that the silicon atom can bond to the glass while the vinyl group participates in the resin polymerization. This strong bond between glass and resin makes it difficult for moisture to travel along glass-resin interfaces; flexural strength, therefore, remains high and fairly constant.

Basic research on the new sizing technique was done by the U. S. Air Force's Materials Laboratory at Wright Field, Dayton, Ohio. Cooperating in the development were Bjorksten Laboratories, Pittsburgh Plate Glass Co., Monsanto Chemical, Glass Fibers, Inc., Owens-Corning Fiberglas, Libby-Owens-Ford Glass Co. and American Cyanamid.

Freeport Seeks More Sulphur In Texas and Louisiana

Prospecting for sulphur, Freeport Sulphur Co. has obtained rights at Nash Dome in Texas and will begin exploratory drilling there.

Nash Dome, about 35 miles southwest of Houston, is the sixth Gulf Coast salt dome at which Freeport is now undertaking to find and develop sulphur. The company recently announced plans to prospect four domes in Louisiana and to build a sulphur mining plant at another dome in that state.

The Nash prospect is known as the Belle Wisdom acreage. While the dome has been partially explored previously, additional drilling will be necessary to determine whether sulphur exists in commercial quantities.

Rotating hearth is the novel feature of a 7,500-kw. electric furnace for smelting phosphate that TVA has recently put into operation. It's expected to be more efficient and economical than a stationary furnace. Tests with a pilot-size rotating furnace show that phosphate fines can be smelted with a saving in cost of preparing the charge.

Viscose yarn plant will be constructed by Beaunit Mills, Inc., and North American Rayon Corp. next to the present plant at Coosa Pines, near Childerburg, Ala. The new plant will produce viscose rayon yarn, is slated for completion in about a year. Capacity: 27 million pounds annually.

—*End*

CHROMALOX

combining Heater and Thermostat in one unit

ready to go on your Jobs!

● CHROMALOX 'Packaged' Electric Heaters are ideal as permanent or portable heat sources in tanks, drums, process kettles and other containers. With CHROMALOX Heaters you can heat accurately and maintain the temperature of degreasing, cleaning, pickling and plating baths. You can melt greases, asphalt and similar viscous fluids. CHROMALOX Units may be had in the types, sizes and wattages required to efficiently do your heating jobs. They are available with sheaths of copper, stainless steel, alloy and lead for resisting the corrosive actions of the solutions you are using.

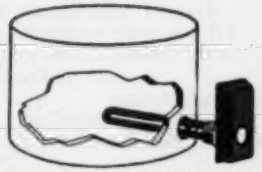
Nation-wide engineering service for on-the-job assistance and recommendations. Write, wire or phone for the name of the Chromalox Engineering Representative serving you.

CHROMALOX

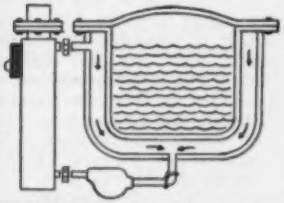
Electric Heat for Modern Industry

Variety and Versatility to fit your Needs Exactly

Chromalox Immersion Heaters with built-in thermostats for portable or permanent use. Drawing illustrates Immersion Units, equipped with sludge-legs, installed over the side of the tank for direct heating. Available in various metal sheaths to resist the corrosive action of the liquid compounds.



Compact, thermostatically controlled, screw-in type, Chromalox Immersion Unit is easily installed in smaller tanks and other containers. Thermostat range is 100° to 180° F.



Chromalox Circulation Heaters give accurate, controlled heat up to 750° F. for heating Dowtherm, Aroclor or heat transfer oils. Other uses include water heating applications such as steam boilers and accumulators, kettles, tanks and processing equipment, preheating fuel oils, heating air, nitrogen and other gases; drying steam, plastic powders, etc.

Clip Coupon

For complete details showing how to use Chromalox Heaters in your applications.

Industrial Division — IC-96
EDWIN L. WIEGAND COMPANY
7514 Thomas Boulevard, Pittsburgh 8, Pa.
Please send "100 Ways to Apply Electric Heat" booklet.

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City_____ Zone____
State_____

Readers' Views & Comments

Fuel Oil I

Sir:

On page 78 of the March, 1951 issue of *Chemical Engineering* . . . you mention the successful use (by Pittsburgh Steel Co.'s Byproduct Coke Div.) of fuel oil as an absorbent medium for removal of light oils from coke oven gas.

We have been using light fuel oil at our St. Louis plant for this purpose since 1940. Advantages were not only lower cost but also a distinct improvement in operation.

. . . I proved by experience and by calculations from Raoult's Law that the type of fuel oils we used was superior to the standard type of absorbent oil recommended . . . and used in most coke oven operations. . . .

After 11 years experience we are still reaping the benefits of this change in absorption medium.

JOSEPH KOHLBERG
Chief Chemist
Great Lakes Carbon Corp.
St. Louis, Mo.

Fuel Oil II

Sir:

. . . I collected data for over a year to refute claims by . . . a number of large oil companies that materials of this nature (fuel oil) could not be used as an absorbent medium. I know of three or four coke plants in this district that are now using oil similar to ours and have increased the light oil removal from the gas at a good savings on the absorbent oil price.

C. R. MONTGOMERY
Chief Chemist
By-Product Coke Dept.
Pittsburgh Steel Co.
Monessen, Pa.

Last Word on Citric

Sir:

Our production men generally agree that your article "Materials of Construction versus Citric Acid" (March, p. 211) appears to be accurate and correct. . . .

From a practical operating standpoint we have found that wood tanks are quite acceptable for dilute crude citric acid solutions up to the boiling point. We have a preference for Type 316 stainless steel for piping and valves at all concentrations and temperatures for both crude and pure citric acid solutions.

We have, however, used Monel for solutions of pure citric acid. We employ lead sparingly for crude citric acid solutions at points where it can be removed before proceeding to finished acid.

If coatings are used on iron tanks, great care must be exercised to protect the coating . . . exposed iron is rapidly attacked by citric acid solutions.

JOHN L. DAVENPORT
Executive Vice President
Chas. Pfizer & Co., Inc.
Brooklyn, N. Y.

We're happy to pass along Mr. Davenport's observations on how to handle citric acid solutions—observations based on Pfizer's quarter century of experience as a leading producer of this acid.—ED.

We welcome pertinent letters from our readers. Address: The Editor, *Chemical Engineering*, 330 West 42nd St., New York 18, N. Y.

More on Process Power

Sir:

Your chart ("Process Power Requirements," March, p. 115) is just the sort of thing that will help a lot of folks in better understanding some of our current economic problems . . . your editors have done a real service. . . .

The factor for electrolytic copper seems to refer to the electrolytic *reduction* of copper. Electrolytic *refining* of blister copper anodes takes much less power, doesn't it?

I don't find electrolytically reduced iron on your list . . . this is important in high frequency reactor cores.

The product that requires by far the most electrical energy per pound . . . and is one of the largest consumers of power in this country . . . is not on the list. I'm referring to uranium 235.

A. T. COURT
Economics Dept.
General Motors Corp.
Detroit, Mich.

(1) *Power for electrolytic refining of blister copper runs around 0.11 kwh. per lb. compared with 1.1 kwh. for reduction.* (2) *Electrolytically reduced iron requires about 1.2 kwh. per lb. Electric furnace smelting takes 1.1 kwh., sponge iron by the Wiberg-Soderfors process about 0.4 kwh. per lb.* (3) *No, uranium 235 isn't on the list for a couple of very good reasons.* —ED.

Asarco Process

Sir:

Your February article "Sulphur and Sulphuric Acid" (p. 121) mentions recovery of sulphur from various sources such as refinery gases. You did not mention the recovery of SO_2 from waste smelter and other SO_2-containing gases . . . this is a source of sulphur that cannot be overlooked since our supply of natural sulphur is dwindling.

. . . mention is made of a plant of the Tennessee Copper Co. at Copperhill, Tenn., which will produce liquid SO_2 at the rate of 25 tons per day. This plant is under license from American Smelting & Refining Co., developer of the Asarco process, and I had the pleasure of starting this plant at Copperhill in the autumn of 1949.

T. CLEON FITT
Selby Smelting Works
American Smelting & Refining Co.
San Francisco, Calif.

Certainly we should have mentioned AS & R's Asarco process, which is now in use by Falconbridge Nickel Co. at Kristiansand, Norway; Tennessee Copper Co. at Copperhill, Tenn.; American Smelting & Refining Co. at Selby, Calif. Another unit will probably soon be installed in Spain by Real Compania Asturiana de Minas—ED.

Zirconium Clarified

Sir:

Increased demand for zirconium has brought about an expansion of manufacturing facilities for both the Bureau of Mines process (March, pp. 116-117) and the iodide process. As the BM type of zirconium is used as head feed for the iodide process, a great percentage of the Bureau's metal is further purified in iodide units. Foote Mineral Co. has been instrumental in engineering the production of iodide-process zirconium from 4-in. diameter glass bulbs to 24-in. metal deposition tubes.

The need for high-purity, corrosion-resistant zirconium made by the iodide method has brought about government sponsorship of several projects . . . to improve the process and to provide additional manufacturing facilities.

Major difference in the iodide and BM types of zirconium is in N_2 and O_2 content—both of which affect properties of the metal. In iodide zirconium, combined N_2 and O_2 are usually held below 0.010 percent; approximate maximum N_2 allowed is 0.008 percent.

The effects of these elements is best shown by typical mechanical properties of the two zirconium products:

Mechanical Properties*	Iodide Zirconium	BM Zirconium
Tensile strength, psi. × 1,000	36.0	68.5
Yield strength, psi. × 1,000	16.0	45.5
Elongation, percent	30.0	13.7
Modulus of elasticity, psi. × 10^6	11.0	...
Rockwell hardness, B scale	30.0	68–76

* Vacuum annealed at 1,450 deg. F.

Annealed BM zirconium metal does not have the ductility, softness and cold working properties of the iodide metal. Ductility is sacrificed by N_2 and O_2 contamination during manufacture.

Resistance to oxidation is also affected. Traces of N_2, Al, Fe and C destroy zirconium's resistance to oxidation in high-pressure steam. The average weight gain by sheet iodide zirconium in steam at 315 deg. C is 15 mg. per sq. dm. per week, whereas ½-in. BM zirconium sheet completely oxidizes under the same test conditions.

The uses to which iodide and BM types zirconium can be applied depend on the engineering requirement. Iodide metal is preferred where maximum ductility and corrosion resistance are of prime importance. BM metal is preferred where these are secondary to strength.

F. B. Litton
C. L. Scheer
S. C. Ogburn, Jr.
Research & Development Laboratories
Foote Mineral Co.
Berwyn, Pa.

This clarifies the differences between zirconium made by Foote Mineral using the iodide process and that made by BM's Kroll process that we described in our March issue.—Ed.

A Brand of Editorial Sin

Sir:

. . . your recent item states . . . "the equipment is made of xxx. . ." As we have reminded other editors during the past year or so, xxx is a registered trade-mark . . . and does not identify any particular composition or material . . . over a hundred different compositions are used in the manufacture of xxx brand products . . . there is no such thing as xxx . . . there are only xxx brand products . . . your item should have said that "the equipment is made of xxx brand products."

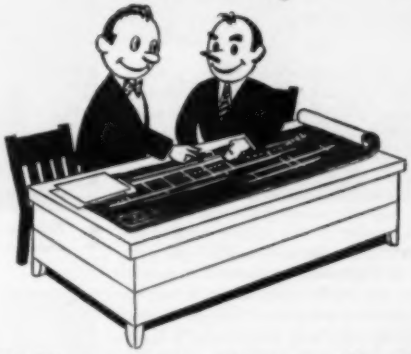
Name Withheld

Patent Dept.

Realizing his sin and the great temptation to repeat it, one of our editors has decided to reform completely by giving up Coca-Cola brand soda pop, Chesterfield brand cigarettes, and is joining the Methodist brand church.—Ed.

TIPS ON SOLVING DRYING PROBLEMS

JUST HOW DOES CONSULTING PROCTOR ENGINEERS EARLY PAY OFF?



Taking Proctor engineers into your confidence just as soon as you know that drying is to be a part of your processing line usually pays off in substantial savings—for you! It makes such plain common sense when you stop to think about it. When drying is a part of a process it is usually a vital link. As such, the equipment should be considered at the very outset of your planning. Its design is dependent upon a number of factors . . . the capacity desired and physical characteristics of the product being two of the chief considerations. Proctor engineers may recommend that to obtain a desired capacity, the product be delivered to the dryer in a certain state and this may govern the type of preliminary equipment needed. Then too, characteristics of the dried material may affect the type of subsequent equipment you will need. That is why it is advisable to consider the problem—as a whole and early! You save time, effort and money by consulting Proctor engineers early. Write today for Bulletin 361 for the complete story of the Proctor approach to solving drying problems. For a lucid explanation of Proctor Drying Systems for the Process Industries, ask for Bulletin 342 as well.

A FEW TYPICAL MATERIALS BEING DRIED IN PROCTOR CONTINUOUS CONVEYOR SYSTEMS

Starch
Titanium Dioxide
Sulfa Drugs
Calcium carbonate
Magnesium carbonate
Clay
White Lead
Finished Lithopone
Soy Bean Protein
Lead Arsenate
Nitro Guanidine

PROCTOR CONTINUOUS CONVEYOR SYSTEMS

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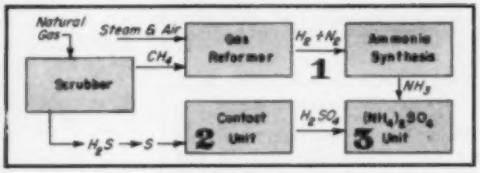


New Plant—Integrated Process

Natural gas, formerly wasted, is the basic raw material for Mexico's self-contained ammonium sulphate plant made up of three different and complete units.

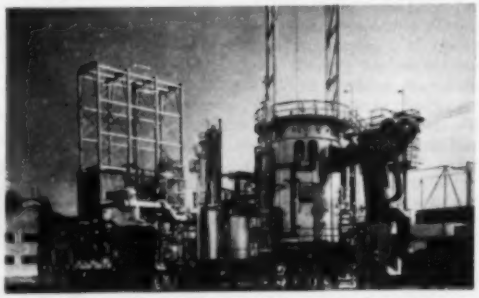
Big, new ammonium sulphate plant of Guanos y Fertilizantes near Mexico City furnishes Mexico with a mutual solution to two problems: (1) how to supply its worn farm lands with low-cost fertilizer, (2) how to make profitable use of wasted quantities of natural gas in Poza Rica fields. The plant not only utilizes natural gas but makes it do double duty. The raw gas is first run through a scrubber. Hydrogen sulphide, the impurity which has to be removed in any case, is led off to provide all the sulphur needed for an outdoor contact unit. The purified natural gas goes on to a reformer where it is processed with air and steam. The reformer turns out a gas mixture composed of 60 percent hydrogen and 20 percent nitrogen. The gases pass on to an ammonia rectifier where, in the presence of an iron catalytic agent, they form pure ammonia. The ammonia and sulphuric acid are brought together in a third unit where the final product, ammonium sulphate, is produced.

Raw gas is delivered via a 124-mi. pipeline—approximately 1,000 cu. m. are required for producing one ton of pure ammonia. In a 24-hr. period, 50 tons of ammonia and 200 tons of sulphuric acid (of which 50 tons are surplus) are turned out. They're combined to produce 200 tons of ammonium sulphate mounting to a yearly total of 70,000 tons. Full operation of the plant is just getting under way though certain units have been functioning since last September.

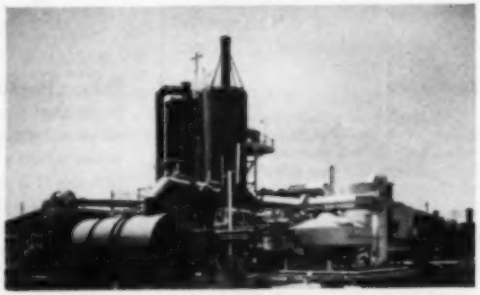
Chemical Construction Co., New York, designed the $10-million operation, first of its kind in Mexico. Blaw-Knox Co., Pittsburgh, were subcontractors. In addition to the contact, ammonia and ammonium sulphate units, facilities for steam, power, water and sewage disposal were constructed on the premises. To build the plant, Mexican labor, building materials, contractors and capital were pooled with U.S. know-how and equipment. The American firms had high praise for Mexican labor.

Capital was supplied by the Export-Import Bank ($5.5 million) and the government's lending agency, Nacional Financieria ($4.5 million).

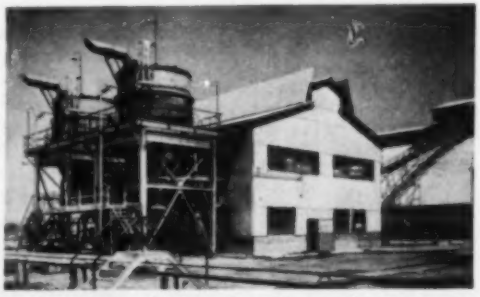
This domestic output of ammonium sulphate will give a big boost to Mexico's program to raise food production. It needs fertilizer to do the job but, in the past, has depended on guano, plus some imported ammonium sulphate. The imports—at $93 a ton—were too costly for the farmers. The new plant cuts the cost down to $41 and brings it within range.



1 Reformer and ammonia unit (background). Natural gas, air and steam to N_2 and H_2 to ammonia.

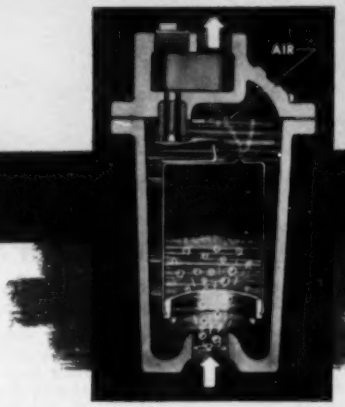


2 Contact unit takes sulphur derived from H_2S, scrubbed from natural gas; turns out more than enough H_2SO_4 for plant.



3 Ammonium sulphate unit combines made-on-the-premises constituents; yields 200 tons a day at low cost.

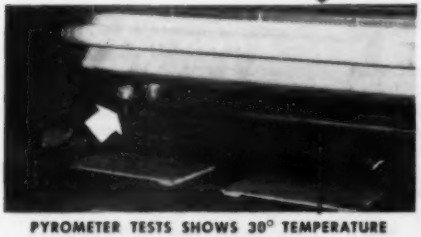
Armstrong traps vent air to give you hotter machines



HIGHER TEMPERATURES MEAN MORE OUTPUT

PSIG	Temp. of Steam with No Air Present	Temperature of Steam Mixed with Various Amounts of Air. (Per Cent Air by Volume)		
		10%	20%	30%
10.3	240.1	234.3	228.0	220.9
25.3	267.3	261.0	254.1	246.4
50.3	298.0	291.0	283.5	275.1
75.3	320.3	312.9	304.8	295.9
100.3	338.1	330.3	321.8	312.4

THIS TABLE TELLS THE STORY. You can't get the maximum temperature you need unless you get the air out.



PYROMETER TESTS SHOWS 30° TEMPERATURE INCREASE on flatwork ironer rolls at *Peter Bent Brigham Hospital, Boston*, after installation of Armstrong traps which vent air along with condensate.

EVERY time an Armstrong steam trap opens there is a momentary pressure drop which "pumps" air down to the trap from the unit being drained. The air passes through the bucket vent and accumulates at the top of the trap to be discharged along with condensate each time the valve opens.

This one basic benefit of the Armstrong trap is saving industry thousands upon thousands of dollars through faster heat-up and higher, more uniform temperatures with resultant greater output and time and labor savings.

You can have this benefit. The cost of Armstrong traps is small in relation to the efficiencies they effect. Call your nearby Armstrong Representative today.

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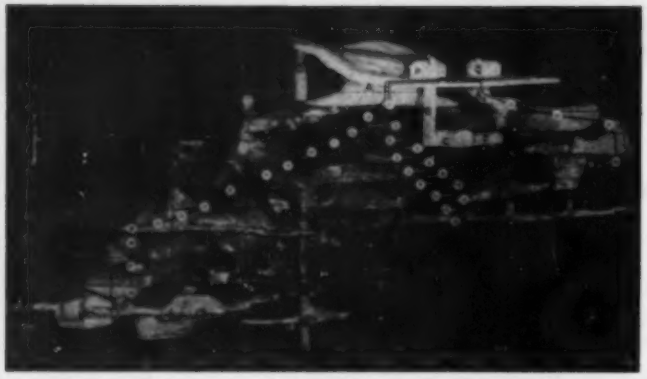
HOW TO SELECT the right trap for each application, installation pointers, prices, capacities, other facts and figures are contained in the 36-page STEAM TRAP BOOK. Send for your copy.

ARMSTRONG STEAM TRAPS



Model of an old feldspar mine now being used as an oil storage tank. It shows control engineers the 32 points at which temperature is electrically measured.

Store Your Oil in an Unused Mine?

The Swedes say it's far cheaper than underground tanks, far safer from wartime attacks than tanks above ground.

The principle is that oil is stored in the mine between sea level and 230 ft. below. Oil is pumped in and out of storage at a point 50 ft. below sea level. The oil level is kept from falling below the 50-ft. mark by pumping water into the bottom of the mine —the last 80 ft. of which is always kept filled with water.

The Swedish government's hydroelectric power board chose an old feldspar mine in the Stockholm archipelago for the project. They wanted to store fuel oil for their steam plant at Vasteras, inland from Stockholm up Lake Malaren. The conversion job took one year. Costs were only one seventh that of underground tanks. Metal cisterns placed in cavities blasted out of the rock would have cost about $25 per cu. m. of storage; the mine only cost $3.50. Even if placed in an existing mine cavity, storage tanks would cost about three times as much.

Only the salt water pumps are above ground. The oil pumps are in a chamber blasted out of rock at the storage intake level 50 ft. below sea level—nearly 90 ft. below ground at that point. In an adjacent chamber are the boilers for the hot water system which keeps the oil flowing freely.

Besides these chambers, a shaft had to be driven for the smokestack and to provide access. Also new is a special gallery for the hotwater radiators which keep the oil at the desired low viscosity. Water is pumped in and out of the bottom of the mine through two holes drilled from the surface to a new passage which was driven to about the 260 ft. level.

Temperature of the oil in the mine, and of the water bed, is measured electrically at 32 points (see cut) through its depth and length. To keep high viscosity oils flowing, the temperature in the outtake gallery can be raised to around 100 deg. F. by means of the hot water radiators installed there. Also, a 1,500 ft. copper heating tube (2 in. diam.) projecting out into the storage area keeps down the viscosity of the upper oil layers when the level is being raised by pumping in water. This prevents oil sticking to the mine walls.

The mine has a further advantage over tank storage in that it doesn't have to be cleaned. Impurities which settle to the bottom of conventional tanks run out with the oil. In the mine, oil is taken out from the top and is practically free from impurities. There is one feature though that's something of a stopper—or at least a challenge to the sporting blood. To inspect this subterranean domain, power board engineers have to row around the surface of the oil in small boats.

Reported this Month . . .

MEXICO

Production of elemental sulphur at an initial rate of 200,000 tons a year will soon get under way on the Isthmus of Tehuantepec near the refinery center of Minatitlan. Frasch process will be used to get at proven reserves amounting to 1¼ million tons of recoverable sulphur; estimated reserves come to several million tons. Mexican Gulf Sulphur Co., a Delaware corporation, and its Mexican subsidiary, Mexican Sulphur Co., have been granted a loan of $1.9 million by the Export-Import Bank of Washington to purchase equipment in the U. S.

SPAIN

Refinery extensions in Teneriffe of the Compania Espanola de Petroleos were officially opened recently by General Franco. Capacity is now 750,000 tons of crude oil a year. Main products are lubricating oils, gasoline, paraffin and petroleum asphalt.

Polyvinyl chloride and caustic potash will be made in Mondoz by Etino-Quimica S.A., of Barcelona. Initial capacity of the polyvinyl chloride plant will be 2 tons a day. Ten de Nora mercury cathode cells rated at 12,000 amp. will turn out the caustic potash which will be exported.

Spain's two penicillin producers—the Urquijo group and Antibioticos S.A. —are to begin manufacture of streptomycin soon.

GREAT BRITAIN

New systemic insecticide, 26 times less toxic than parathion and a little more than twice as toxic as DDT, has just been made available in commercial quantities by Pest Control, Ltd. Called Isopestox, its chemical name is bis isopropylaminofluorophosphine oxide. Properties: solid, melting at 60 deg. C., very hygroscopic, non-corrosive, non-volatile, odorless. When sprayed on plants it is not selective but will kill aphids, red spiders, thrips, white fly and their larvae, scale insects and mealybugs.

Titanium dioxide pigments will soon be produced at plant of National Titanium Pigments, Ltd. It is under construction on a 37-acre site at Stallingborough, Lincs. Ilmenite for the plant will come from Malaya and pyrites from Cyprus.

Sulphuric acid consumers have decided to go ahead with plans for a $11.5-million plant to produce the acid from domestic sources of mineral anhydrite. Probable site: Mer-

(*Continued*)

seyside; estimated production: 150,000 tons of acid a year. Priority is to be given in the delivery of materials and equipment for the plant so that supplies of acid from the new works should start in about two years. ICI is assuming technological responsibility for design and the initial stages of operation. Fisons Ltd., the fertilizer manufacturers, and Courtaulds Ltd., rayon manufacturers, are two of the big sulphuric acids consumers putting up the capital.

Cellulose acetate plant of Hercules Powder Co. Ltd. will commence operations in Lancaster some time this year. Manufacturing techniques of the U. S. parent company will be used.

SOUTH AFRICA

New oil from coal plant of South African Coal, Oil and Gas Corp., Ltd., will use the Synthol process, not the Hydrocol process mentioned in this department's item on the plant in March, p. 204. M. W. Kellogg Co., over-all project managers, developed the process to be used.

Standard-Vacuum Oil Co. of the United States is putting up the capital for the establishment of a $12.6-million refinery at Wentworth, Durban. Operations are expected to start late in 1953. More than 125 million gallons of crude will be processed yearly, with gasoline the main product. The operating company, known as the Standard-Vacuum Refinery Co. of South Africa, will be headed by Bryant F. Kenney, former assistant general of Esso Standard Oil Co.'s Bayway, N. J., refinery.

GERMANY

Synthetic fiber from furfural process has been developed to the large experimental plant scale by the Phrix-Werke A.G. of Hamburg. The new fiber, called Phrilon fiber, is similar to nylon and perlon in many respects. The firm is also at work developing a fiber similar to Orlon.

Titanium dioxide pigments production is scheduled for an increase by Titangesellschaft of Leverkusen. This company, the only titanium oxide producer in West Germany, suffered bomb damage in 1944 estimated at 80 percent of capacity and only regained its prewar level of

(Continued)

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FOREIGN NEWS, cont. . .

production by the middle of 1949. Extensions now under construction should be in operation this summer; plans as a whole call for the doubling of present capacity. Several new grades of pigment for special purposes are under development.

Materialization of the plans are partly dependent upon some modification of Allied policy in regard to the decartelization of the former I.G. The titanium plants form an integral part of the Leverkusen works of the Farbenfabriken Bayer and are dependent upon other units in these works for their supplies of acid, electric power and other materials and services. However, by the latest decartelization plan, the titanium firm is to function independently of the Bayer company.

A new phosphorus furnace is being built by the Piesteritz Works in Eastern Germany. When it starts operating later this year, the works will have an export surplus of phosphoric acid. A large new carbide plant is also being built at Piesteritz; in all, production capacity will be increased by 30 percent above its 1950 level. The Bitterfeld electrochemical works has started up a new electrolytic alkali plant.

FRANCE

Monochloroacetaldehyde is now being made by Cie. de Saint-Gobain by a process starting from monomeric vinyl chloride. It is marketed in the form of a crystalline semi-hydrate of minimum 97 percent purity, and as 25 percent and 50 percent aqueous solutions. The material, which has a high degree of reactivity, is expected to be useful in synthesis.

SWEDEN

Swedish Pulp Co.'s production of semi-chemical pulp will reach full proportions by the end of the year. The return of Japan as a customer and a new Australian market prompted the company to start up the operation.

A paper mill to cost 45 million rupees is under construction in East Pakistan on the Karnafulli River. It will commence operation toward the end of the year but full capacity, 30,000 tons of paper per year, will not be reached until 1953.

Silica sand deposits which appear of good quality have been discovered

(Continued)

For

corrosive liquids

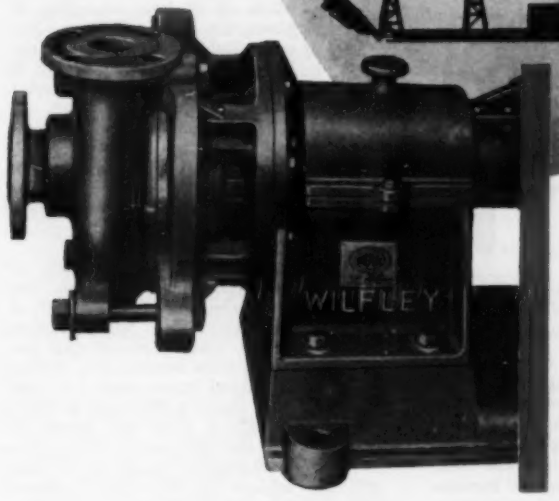
Electrolytics

Antibiotics

Pharmaceuticals

Fertilizers

Steel Picklers



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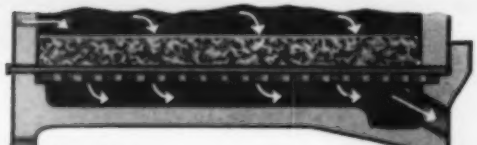

Cross-section of individual plate, showing perforated metal screen, filter media, and filter cake.

High flow rates cannot be assured by large filtering surfaces *alone*. Another important factor is provision for drain-off space capable of carrying away all liquid that the surfaces can handle.

In Sparkler filters, the Free Drainage design of Sparkler horizontal plates eliminates one of the primary causes of liquid flow frictions — providing a clear, unobstructed channel through which filtered liquid can drain rapidly and more completely. To accomplish this, Sparkler uses a series of smooth, widely spaced buttons as the means of supporting the filtering surface, thereby ending the need for heavy wire mesh or other types of media support that have high coefficients of friction.

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Foreign News, cont. . .

near Jungshahi, Sind. Covering an area of 2 sq. mi., the total deposits are estimated at 315,000 tons.

New sulphur reduction process for iron has been used on an industrial scale by the Domnarvet Iron Mills in Central Sweden for the past six months. The method involves use of coke and burnt lime; sulphur content goes from 0.090 to 0.005 percent. At the same time, the proportion of silicon is reduced to about 10 percent.

ITALY

Oil refineries of L'Aquila Co. of Trieste will soon be starting work. Made up of four lubricating oil plants, the works will be the largest in Italy for size and potential. They will be able to supply 50 percent of the country's market. Now 80 percent is imported.

The $8.5 million plant (financed half by ERP and half by the Trieste company) will be first in Europe to use crude carried from the Middle East through the trans-Arabian pipeline.

Natural steam power plants at Larderello in northern Italy have been rebuilt and expanded to almost twice their prewar kilowatt output. These plants generate electricity from inexhaustible torrents of natural steam which roar forth from cracks in the earth at speeds as high as 1,300 fps. Before the war, the power and chemical plants of Larderello produced a yearly average of 980 million kilowatt hours of electricity and many thousands of tons of raw 95 to 97 percent pure boric acid and other chemical byproducts of the chemically rich steam.

A synthetic resins plant has been built at Casoria near Naples by Resia S.p.A., Italian affiliate of Reichhold Chemicals, Inc. The $1 million plant is also equipped to refine glycerine and to press and refine vegetable oils. Construction of both phthalic anhydride and a pentaerythritol production unit is under consideration.

CANADA

Anhydrous aluminum chloride is now being produced in Canada for the first time at the Aluminum Co. of Canada's plant at Arvida. Annual output will be 3,000 tons, enough to supply the Canadian market

and leave some for export. Raw materials will be aluminum scrap and chlorine from its chlorine and caustic soda plant at the same site.

Principal Canadian consumer will be the Polymer Corp. at Sarnia, Ont. It will use 300 to 400 tons annually as a catalyst in the manufacture of synthetic rubber. Polymer Corp. has been bringing in its anhydrous aluminum chloride from the United States where supplies are now tight.

New type synthetic rubber known as polysar krynol is now being commercially produced at the Sarnia, Ont., plant of Polymer Corp., Ltd. It is reportedly much easier to mix, extrude and handle in rubber plant equipment than any other type of synthetic rubber produced. The new material is the result of a year's research and cooperative effort between Polymer and General Tire & Rubber Co., Akron, Ohio.

Canadian sulphur produced from petroleum will be supplied to the British Columbia pulp and paper industry within a year. Shell Oil Co. of Canada will build a $500,000 plant about 30 mi. from Calgary, Alberta. Nearby, new facilities for processing of large volumes of natural gas makes available a constant source of sulphur. Initial production will be 10,000 tons a year.

Refinery now being built at Edmonton by the British American Oil Co. Ltd. in a complete combination plant. Key to the processing sequence, according to the designers—M. W. Kellogg, is the segregation of light and heavy feeds stocks for thermal and catalytic cracking. This operation is handled in an unusual combination bubble tower which fractionates effluent from both the thermal cracker and the delayed coker as well as light cycle oil from the fluid cat. Light ends off the top of the tower go to the vapor recovery group which processes all refinery gaseous products. The overhead liquid product is a blend of coker and thermally cracked gasoline which is stabilized separately from the catalytically cracked gasoline. A mixture of light cycle oil from the cat and light gas oil from the coker is withdrawn from the upper section for thermal cracker feed stock. Below this, heavy gas oil is taken off as cat cracker feed. The bottom product is tar.

—End

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Materials of Construction vs. Ferric Chloride

Stainless Steel

GRANT L. SNAIR, JR., *Allegheny Ludlum Steel Corp., Brackenridge, Pa.*

The stainless steels are particularly susceptible to corrosion by ferric chloride. Although Types 316 and 317 are more resistant to attack by pitting than any of the other stainless steel grades, even these grades are not usually sufficiently resistant to ferric chloride or its solutions to be dependable in service. Types 316 and 317 occasionally provide adequate corrosion resistance during short periods of exposure to solutions containing not more than 10 percent ferric chloride at room temperature. Thorough washing is necessary after use. Complex equipment designs should be avoided, and the metal must be free of stress as well as flaws, crevices, and precipitated carbides resulting from welding.

Chloride ions in solution, especially ferric chloride, possess the ability to penetrate or destroy the passive surface film of the stainless material. Where the austenitic (chromium-nickel) stainless steel grades are concerned, the attack is characterized by random penetration of the surface of the metal followed by rapid complete perforation. The rate of corrosion is accelerated as the temperature increases. Solutions of ferric chloride tend to hydrolyze upon standing, forming hydrochloric acid which hastens attack.

Worthite

W. E. PRATT, *Worthington Pump and Machinery Corp., Harrison, N. J.*

Worthite is not a commercially suitable material for handling ferric chloride. However, there are many solutions containing ferric chloride in small amounts that are not corrosive to Worthite. Thus certain dyes containing ferric chloride are handled in Worthite pumps. Also, liquids that have been treated with ferric chloride, such as factory effluents, are not considered at corrosive to the alloy.

Ferric chloride, cupric chloride, and certain other acid chlorides have the ability to penetrate the passive oxide film on chrome-nickel and nickel-chrome-low moly alloys and promote severe pitting. Any proposed application should therefore be checked very carefully and more attention should be paid to the tendency for pitting rather than to the overall weight loss.

Nickel and Nickel Alloys

W. Z. FRIEND, *International Nickel Co., New York, N. Y.*

Nickel, Monel, Inconel and the Ni-Resist alloys are rapidly attacked by ferric chloride except in very dilute solutions containing less than 0.5 percent FeCl, at atmospheric temperature. All of these materials have found useful application in the handling of some effluents from the ferric chloride treatment of sewage where the residual ferric chloride content does not exceed 0.2-0.3 percent. Concentrated ferric chloride solutions are used for the decorative etching of these materials because of its rapid attack.

Rubber Lining

J. P. MCNAMEE, *U. S. Rubber Co., Providence, R. I.*

Natural and synthetic rubber compositions are unaffected by saturated ferric chloride within the temperature limitations for these lining compositions.

Soft natural rubber lined steel makes an excellent material of construction for ferric chloride storage tanks in water purification plants. Linings of this type may be applied to tanks of any size after erection and are vulcanized in place using low pressure steam. The resulting lining is in the form of a continuous protective membrane $\frac{1}{16}$ to $\frac{1}{4}$ in. thick, well adhered to the metal base and free from porosity and other defects which can cause a lining failure.

Cements

RAYMOND B. SEYMOUR, *Atlas Mineral Products Co., Mertztown, Pa.*

Practically all known commercially available chemical resistant cements are suitable within temperature limitations of the materials for use with aqueous solutions of ferric chloride regardless of the concentration. Alumnite cement, Portland cement, and admixtures are badly attacked. Silicate cements exhibit high adsorption and, therefore, are not recommended.

Cements based on thermoplastics such as asphalt, petroleum resins, polyvinylidene chloride or polyvinyl chloride are satisfactory at temperatures up to 125 deg. F. Plasticized sulphur cements are satisfactory at temperatures up to 200 deg. F., while cements based on phenolic or polyfurfuryl alcohol resins are satisfactory at temperatures as high as 250 deg. F. Cements based on polymers of furfuryl alcohol have given satisfactory service as jointing materials for brick and tile in both floors and tanks over a period of years.

Aluminum

ELLIS D. VERINK, JR., *Aluminum Co. of America, New Kensington, Pa.*

Aluminum alloys are attacked by ferric chloride solutions not only because of the formation of the hydrolysis product (hydrochloric acid) but also because aluminum is oxidized by the reduction of ferric to ferrous ions. When an oxidizing agent such as dissolved oxygen is present, a series of cyclic reactions results in which the ferrous ion is reoxidized to ferric and the reduction cycle again proceeds.

High-Silicon Irons

WALTER A. LUCE, *The Duriron Co., Dayton, Ohio*

Ferric chloride is one of the most corrosive chemicals known and is extremely destructive to most commercial metals and alloys. It normally attacks the stainless steels, high-silicon irons and many other alloys resistant to oxidizing corrosives by the pitting type corrosion. Because of its high oxidizing capacity, it severely corrodes the remaining alloys in a uniform manner.

Although the high-silicon irons are susceptible to pitting and concentration cell corrosion in many ferric chloride solutions, these alloys do find application for handling certain specific concentrations. For instance, Duriron and Durichlor equipment has found application for many of the dilute solutions normally encountered up to approximately 10 percent. Above that concentration, unexpected and

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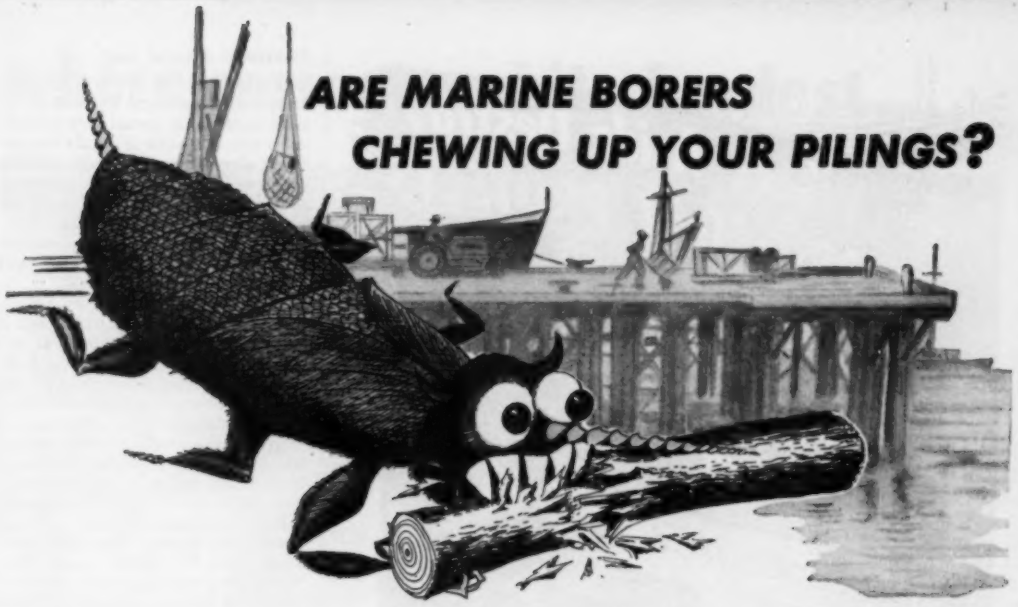

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Preventive Maintenance PAYS

rapid corrosion can often occur. The temperature limitation for these alloys is ambient unless special tests indicate otherwise. Durichlor is usually the preferred alloy for handling ferric chloride solutions, but in many instances, Duriron apparently is the equal of the molybdenum containing alloy. However, Durichlor is definitely superior for hydrochloric acid, chlorine, and many other chloride solutions.

The unpredictable and erratic nature of ferric chloride attack makes it very difficult to conduct reliable corrosion tests, especially with the high-silicon irons since these alloys do not pit under normal test conditions. It is usually necessary to conduct tests of long duration and under conditions which favor either pitting or concentration cell corrosion. Failure to observe these special conditions may result in unreliable data and failure of equipment. Pumps, valves, and other equipment all contain many areas where concentration cells can exist and where pitting may occur. Weight loss data with this corrosive is not too important unless the susceptibility of the alloy to these two types of corrosion is closely observed.

Mixtures of ferric chloride and hydrochloric acid in substantial quantities are also difficult to handle and adequate testing of these alloys is suggested before they are considered for equipment. Durichlor is extensively used for handling many concentrations of hydrochloric acid, but the presence of ferric chloride even in relatively small percentages is capable of rendering this alloy unsuitable especially in the more concentrated solutions. (See Corrosion Forum, Dec. 1948 and Jan. and Feb. 1949 for a more extensive discussion of this point.)

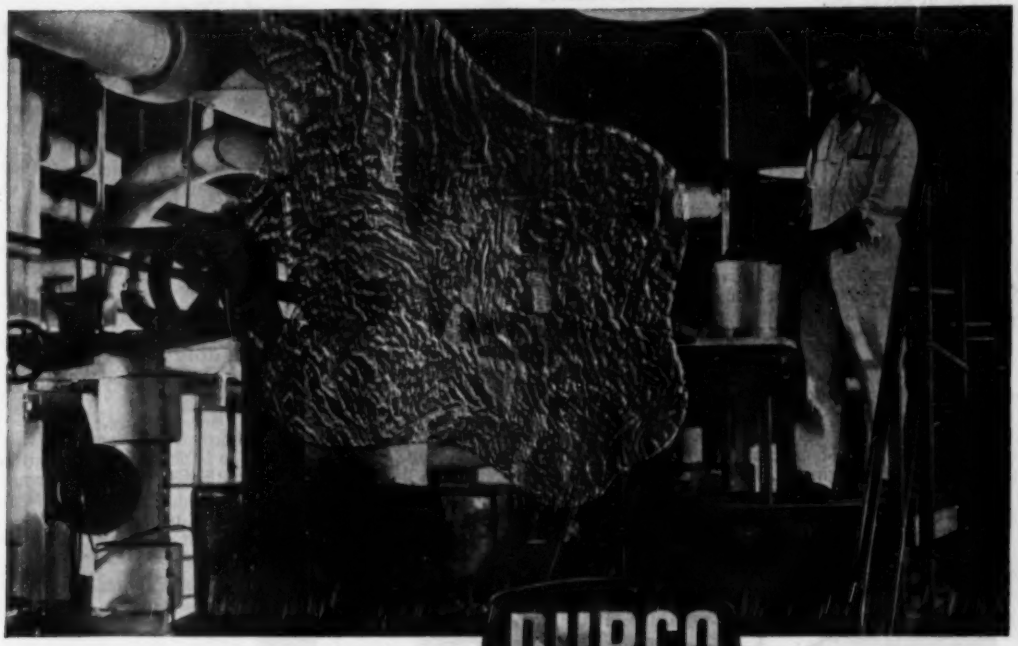
Durimet 20

WALTER A. LUCE, *The Duriron Co., Dayton, Ohio*

Durimet 20 is not recommended for handling ferric chloride at any concentration normally encountered. Corrosion tests show that very high corrosion rates are obtained with the pitting type corrosion very much in evidence. For example, tests in pure 10 percent ferric chloride at ambient temperatures showed a rate of 330 mils per year with extensive pitting. The presence of 1.0 percent hydrochloric acid in the above test service increased the rate of attack two times. Extensive pitting was again in evidence. However, these rates are not indicative of the service life of plant equipment since the samples were

(*Continued*)

where corrosion hits hardest...



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The Duriron Company, Inc., Dayton, Ohio

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almost perforated in the short test period of only five days. Thus, plant equipment in this alloy would show very short service life.

Durimet 20 is available in both cast and wrought form. Castings include pumps, valves, fans, jets and mixing nozzles. Wrought products—wire, rod, bars, strip, welded pipe and tubing—are produced by Carpenter Steel Co. under the name Carpenter 20.

Carbon and Graphite

R. O. JOSLYN, *National Carbon Co., Cleveland, Ohio*

Carbon, graphite, and impervious carbon and graphite are chemically resistant to all concentrations of ferric chloride solutions to the boiling points.

Impervious graphite has been widely adopted for the fabrications of corrosive chemical heat exchange equipment because of its high thermal conductivity and ease of machineability. Typical installations in ferric chloride service are standard tube and steel shell exchangers cooling 400 gpm. of ferric-ferrous chloride solution in an electrolytic iron plant, and an impervious graphite immersion-type heat exchanger maintaining a 130 deg. F. operating temperature in a ferric chloride etching solution.

Chlorimets

WALTER A. LUCE, *The Duriron Co., Dayton, Ohio*

With the Chlorimets as with any of the commercial metals and alloys, extreme care must be exercised prior to using in contact with ferric chloride.

Chlorimet 2 is definitely unsuitable since its lack of resistance to oxidizing solutions causes it to corrode very rapidly. The chromium containing Chlorimet 3 alloy, however, shows good resistance to many ferric chloride concentrations at ambient temperatures. Tests have been conducted on concentrations up to 50 percent with good results. However, tests must be conducted on each and every application to gage correctly any deviations from known test solutions.

Temperature has a marked effect on the resistance of Chlorimet 3 to ferric chloride. For instance, 2.5, 5.0, and 10.0 percent solutions showed no appreciable corrosion or pitting at normal temperature. Increasing the temperature of the 2.5 percent solution to 195 deg. F. increased the rate of corrosion slightly but did not indicate any tendency to pit. At 250 deg. F., however, extensive pitting was noted. A 50 percent solution at 176 deg. F. showed a corrosion rate in the order of 2,500 mils per year.

The presence of hydrochloric acid with ferric chloride is apparently capable of rendering the Chlorimet 3 unsuitable even in relatively dilute solutions. Not only is the corrosion resistance to general attack decreased but pitting corrosion may occur. There is no general pattern to follow since pitting may be encountered at very low hydrochloric acid concentrations as well as at the high concentrations. These varied data only serve to indicate that corrosion testing in ferric chloride media is difficult and can often lead to erroneous conclusions.

Glass Lining

S. W. MCCANN, *The Pfaudler Co., Rochester, N. Y.*

Glass-lined steel equipment is fully resistant to ferric chloride solutions in all concentrations up to the normal boiling point and above. Normally no units are used to process ferric chloride alone, but in many cases ferric chloride is handled successfully as an

(Continued)

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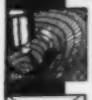

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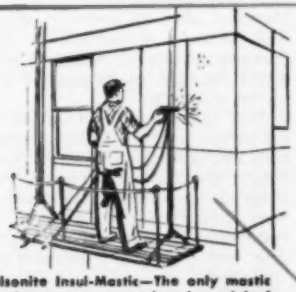

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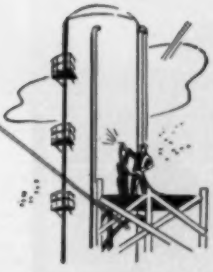

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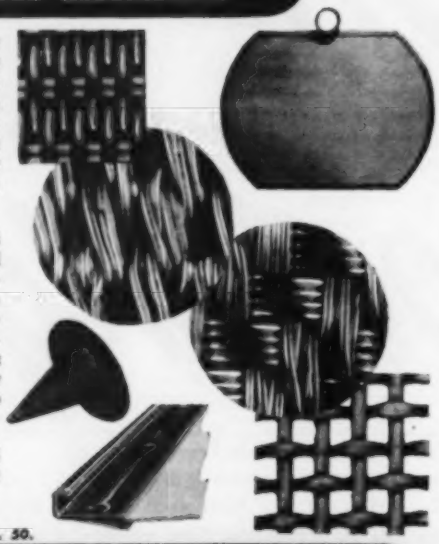

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ingredient in a reaction. This has been done in standard jacketed reactors and other standard units of glass-lined steel.

Hastelloy

E. D. WEISERT, *Haynes Stellite Co., Kokomo, Ind.*

Hastelloy alloy C has excellent resistence to the corrosive effects of solutions of ferric chloride at moderate temperatures. At room temperature, the corrosion rate of wrought alloy C is about 0.3 mils per year in solutions of low concentrations; the cast alloy shows a rate of about 10 mils per year. These rates rise only slightly with increases in concentration.

The presence of oxidizing acids in the ferric chloride solutions does not essentially change the resistance of Hastelloy alloy to corrosive attack. The presence of hydrochloric acid does not increase attack beyond what would be expected from a solution of the acid alone.

Alloy C has been used successfully for pumps, pipe and fittings, heating coils, and etching machines that must handle ferric chloride over a wide range of concentrations. At temperatures above 70 deg. C., however, the corrosion rate tends to become erratic and pitting is sometimes encountered.

Wood

HENRY B. SMITH, III, *Michigan Pipe Co., Bay City, Mich.*

Ferric chloride solutions above 15 percent are active on wood. Wood has given economic service for handling ferric chloride solutions as high as 25 percent in water treatment and smelting. However, we do not generally recommend wood for use with this higher percentage.

Coatings

KENNETH TATOR, *Kenneth Tator Associates, Coraopolis, Pa.*

Ferric chloride, like copper sulphate, is a acidic salt of a strong acid with aggressive oxidizing tendencies. Consequently the performances of, and recommendations for, organic barriers already discussed for copper sulphate solutions (Chem. Eng., April 1950, p. 212) are equally pertinent to ferric chloride.

Thin barrier films should be avoided due to the aggressive corrosion action, and non-oxidation resistant organic barriers may give adc

quate service life. Oxidation resistant materials will give maximum service life, and evidence of oxidation becomes evident by color change.

The polyvinyl copolymers and polyvinylidene chlorides should be effectively stabilized against chloride impermeation. Soft natural rubbers will give a better performance than with copper sulphate solutions due to formation of an inert rubber hydrochloride surface film.

Tantalum

LEONARD R. SCRIBNER, *Fansteel Metallurgical Corp., N. Chicago, Ill.*

Tantalum is inert to ferric chloride, either wet, dry or in solution. Tantalum has been used with excellent results for heating ferric chloride etching and pickling solutions, also for essential exposed parts in equipment for introducing ferric chloride into sewage.

Silicones

J. A. MCHARD AND J. T. MCINTYRE, *Dow Corning Corp., Midland, Mich.*

Silicone Fluids—A representative methyl polysiloxane and a fluid typical of the mixed aryl and alkyl polysiloxanes were used as fluid specimens in tests where changes in viscosity and appearance were taken as measures of chemical resistance to iron chloride.

The methyl polysiloxane shows better viscosity stability. In neither fluid was there any evidence of gelation. Iron chloride appears to be somewhat soluble in the silicone fluids, based on an observation of color changes.

Silicone Greases—Practically no service data are available on the resistance of the compounds and greases to ferric chloride. One lubricant has been used successfully, however, in services handling aluminum chloride. In one instance, this silicone lubricant performed well in valves handling a mixture of aluminum chloride and aromatics at temperatures as high as 175 deg. C. In another application the lubricant failed in contact with solid aluminum chloride.

Silicone Elastomers—The elastomers show varying resistance to ferric chloride. A formulation specially designed for gasketing applications shows good resistance to 60 percent ferric chloride at 100 deg. C. Other stocks are subject to cracking and loss of toughness. Shore hardness and elasticity are not appreciably altered.

Silicone Resins—The resins are characterized by good resistance to ferric chloride at 100 deg. C. Specimens exhibited no weight loss and no changes in color or appearance.

—*End*

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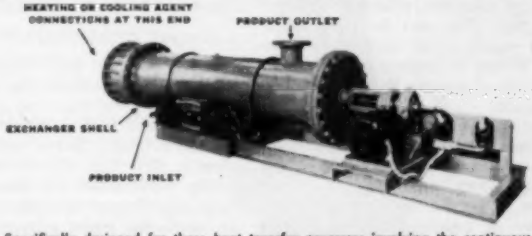
AUTOMATIC SELF CLEANING HEAT EXCHANGER



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What Makes A Leader?

The old question of what makes a man a leader is getting a lot of attention from chemical managements these days. The industry's rapid rate of expansion has drained the usual wells of executive talent at a faster rate than they can be replenished. As a result many companies have been forced to advance men more on the basis of promise than proved performance.

Naturally in such a situation there is a mad scurry on the part of managements to gain the services of any testing device or organization that claims to be able to spot latent executive or supervisory talent a mile off. And the claims to such abilities have been many . . . so many in fact that the reputable consulting firms in the field of executive development work have had to get off their professional dignities and demonstrate why some of the handy foolproof methods won't work when it comes to picking leaders. Their general feeling is that although there are many helpful tests that can be used, there is absolutely no substitute for a common sense approach based on a few basic facts.

An interesting summary of recent research on leadership qualities appeared in the March issue of *Personnel*. Its author, Cecil E. Goode, an ESA official and president of the Society for Personnel Administration took the occasion to delve into some notions about the art of leading others.

A GENERAL CHARACTERISTIC?

It has generally been believed that leadership is specific to the situation . . . that a given time and job to be done will call forth a different leader for the moment. But a recent study seem to show that executive and leadership requirements are basically the same regardless of the nature of work in which the leader is engaged.

The same study also blasted the old conception that the leader must be more skilled technically than his subordinates. Supervisory and administrative skills were found to rate substantially above technical skills among successful supervisors.

In a *Fortune* survey of successful executives the same observation was made. A husky percentage of the men tested believed that there were certain characteristics needed for every type of executive position. Almost without exception these characteristics were named as the ability to handle people and the ability to make decisions.

ARE TYPICAL LEADERS EXTROVERTS?

A thorough study by a group at Ohio State University concludes that the relationship of either introversion or extroversion to leadership is extremely vague. This punctures the popularly held notion that the successful leader is always equipped with a powerful right hand and a flashy smile. In fact the same study also shows that there is little correlation between leadership and physique unless a severe disability or weakness exists. Much more significance is attached to the health, energy and vitality of the man.

IS MENTAL ABILITY A KEY?

A large range of studies on the problem indicate that there is a positive relationship between mental ability and leadership. But the experts claim that fact is no reason to feel that the more intelligent the leader, the better leader he makes. The effective situation exists when the leader is generally only a shade more intelligent than the average of his followers. Great intellectual superiority on the part of the executive introduces obstacles in his getting over ideas to his subordinates.

Breadth of interests is another hallmark of the successful executive. A study by a Carnegie Institute of Technology group claimed that "the executive is a well rounded individual who does not deviate outstandingly from the average shown by persons of general intellectual superiority."

Maturity and a generally healthy attitude toward society is another requisite of the capable executive. Surveys have shown that such leaders have a passion for objectivity and are free of the habit of drifting from one extreme to another.

The importance of adequate motivation in the makeup of a good-executive can be seen from a *Fortune* survey in which 94 percent of the executives who were interviewed emphasized the value of "capacity for work," and "an ability to see things through." Imagination was also listed as one of the six main reasons for their success.

Speech facility has also been stressed by the experts as a quality of the good executive. One investigator even went so far as to find that sociability correlates from .33 to .98 with leadership. And tact and courtesy were also found to be part

(*Continued*)

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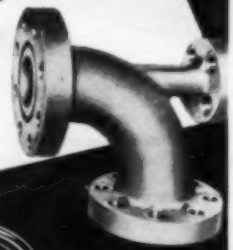

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of the social equipment of the men who lead.

WHAT ABOUT MILITARY LEADERSHIP?

It is interesting to note the similarity of characteristics between civilian executives and military officers. In the book, "Psychology of Military Leadership" by Pennington, Hough and Case, emphasis is placed upon the need for decisiveness in officers, and the courage to carry out decisions once made.

A thorough knowledge of his men is also mentioned as a basic requirement of a military leader and, as with executives, good officers were found to possess considerable tact in dealing with their subordinates.

The handbook on military leadership also points out that smallness of physical stature has little or no effect upon the leadership potential of a man. It cites Nelson and Wellington, both of whom were relatively small men. And then of course, there was Napoleon.

But perhaps the most striking correlation between the specifications for military and industrial leadership is that both agree that great intellectual superiority of leader over his followers may actually be a handicap to efficient command. The military experts sum it up by saying. . . . "the officer must early realize that intelligence is only one of the essentials of leadership."

PARADOX OF LEADERSHIP

The fact that intellectual superiority (of a slight degree) is only one component of leadership usually comes as a shocker to technical men . . . and understandably so. Their formal training has stressed individual ability to handle problems as the basis for advancement. And they know that I.Q. has long since proven to be a fairly good predictor of technical ability both in engineering and in the natural sciences.

But leadership is a pragmatic art, not an exact science. The ability to solve brain-busting technical problems is no more of an index of industrial leadership than a high crossword puzzle proficiency would be of a man's ability as a combat officer. In fact it is almost axiomatic that the "intellectual," even with proved technical ability, is not always a good risk as a leader. The better bet is the possibly mediocre man who can catalyze the efforts of others—the inspirer.

"HUMAN EQUATION" . . . Q.E.D.

With this printing the "Human Equation" series comes to an end.

And it is sincerely hoped that its 12 installments have worked to provide readers with a little food for thought and reflection on an important topic —the closing of the gap that exists between the technical and the lay worlds and the men who populate both.

That this gap be closed is not only a desirable thing but a necessary step in the evolution of our economy and society. Unfortunately, due to a penchant for specialization many technically trained men have either forgotten or neglected to learn that the human constituent of any situation is always the most important. Science and technology are the servants of human needs and drives—not the masters.

This does not mean, however, that the technologist must be relegated to a position of mute service. On the contrary and today more than ever before, technically trained men have the privilege and duty to initiate and direct constructive thinking in all fields and on all subjects. But to do this effectively, they must keep one ear open to the needs, troubles and tempo of the everyday life of laymen. They must never allow themselves to develop a snobbery that sneers at anything that cannot be resolved by a sliderule. In a word they must never become so "technical" that they cease to be human.

THANKS . . . .

In these last paragraphs the editorship of the 'Human Equation" wishes to take the opportunity to thank the various individuals who by their constructive criticism have helped to make the writing of HE an enjoyable experience and, we hope, helpful reading.

First thanks must be expressed to Dr. Richard S. Schultz, Director of Industrial Relations Methods Inc., who gave freely of his vast experience in the field of human relations in industry. Conversations with Dr. Schultz opened our editorial eyes to many of the problems of the technical man serving in industrial occupations.

Also to be thanked are Major Charles T. Estes of the Federal Mediation and Conciliation Service and the eminent author and economist, Stuart Chase. Their encouraging comments convinced us that we were on the right course in stressing the social and economic needs for closer rapport between technical men and laymen—between science and the art of living.

And thanks would not be complete without a good share of them being sent the way of the numerous readers whose pro and con letters have helped us set that course and sail it. —*End*

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Names in the News

Edited by Frances Arne

MAN OF THE MONTH

Manson Benedict

. . . one of industry's top atomic engineers who goes to MIT "to expand and strengthen the educational program in nuclear engineering."

Almost as rare as "man bites dog" is the news that industry is giving up one of its top engineers to the educational world. Manson Benedict is leaving his job as director of process development for Hydrocarbon Research, Inc., to become professor of chemical engineering at MIT. The Institute plans to build around him a formal program of education in nuclear engineering, initially at the graduate level.

Dr. Benedict, friendly though a shade on the quiet side, has used the old reliable combination of hard work and brains to open his doors to success in the chemical industry. He received his bachelor's degree in chemistry from Cornell in 1928 and a Ph.D. in physical chemistry from MIT in 1935. From 1938 to 1942 he worked with M. W. Kellogg to develop a widely used equation of state for hydrocarbon mixtures. Until 1946 he was with Kellex Corp. in charge of process design of the gaseous diffusion plant for the concentration of U-235 built for the Manhattan Project at Oak Ridge. In 1946 he was chairman of the technical committee on the control of atomic energy of the War Dept. He is a member of the: atomic energy and research committees of AIChE; reactor safeguard committee of AEC; visiting committee for the reactor science and engineering department of Brookhaven National Laboratory. While at MIT he will do consulting for the National Research Corp. and for AEC.

Nights, week ends and holidays Dr. Benedict writes papers and "does a little real thinking." His papers on extractive and azeotropic distillation won him AIChE's Walker Award.

All this doesn't leave much time for hobbies though he has a list of them he plans to get to some day. Daughters Mary and Marjorie (aged 13 and 12) are not so patient and they have a way of impressing their father into service. Last summer they lured the family out to a dude ranch in Colorado. Horseback riding never was on Dr. Benedict's to-do list and this trip proved to him how right he was. However he grudgingly admits its advantages in mountain climbing, of which he is very fond. Somehow he always manages to work at least one expedition a year into his schedule. He has never lost a love of the outdors bequeathed by his boyhood spent in the wilderness of northern Michigan.

He is also addicted to music and has always had a craving to be able to play an instrument. A few years ago a friend presented him with a recorder, a sort of simplified second cousin to a flute. Mrs. Benedict reports that he's become something of a virtuoso. Now his enjoyment of the old masters is complete.

James J. Morris. Chief of plasticizers and amines, aromatic section, chemicals division of NPA. Formerly with the fine chemicals division, Carbide and Carbon Chemicals Co. working on sales and development of plasticizers and solvents.

John C. Van Horn. Assistant manager, technical service and development division, Dow Chemical Co. Joined Dow in 1946; formerly with Du Pont. Graduate of Purdue.

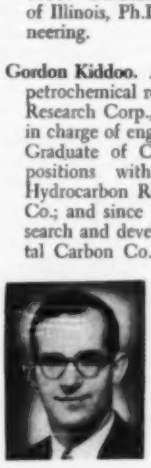
Harry N. Holmes. Winner of the 1951 Gold Medal of the American Institute of Chemists. Emeritus professor of chemistry, Oberlin College. Known for his research on vitamins. Graduate of Westminister College and Johns Hopkins.

W. H. Bowman, Max Neuhaus and **L. P. Scoville.** Vice presidents of Jefferson Chemical Co. Mr. Bowman: market development manager and manager of the sales department. Studied chemistry and chemical engineering at the University of Toronto and NYU; has been on the faculty of both and Case Institute of Technology. Previous industrial association with Shawinigan Chemicals Ltd., Armstrong Cork Co., Westvaco Chlorine Products Corp. Mr. Neuhaus: Manager of Jefferson's technical and research department since the company's formation in 1944. Previously with the Texas Co. and Texaco Development Corp. Studied at Rice Institute, Technisch Hochschule in Berlin, MIT. Mr. Scoville: joined Jefferson in 1944 as chief engineer; became manager of the production department. Formerly with the Texas Co. as senio. engineer. Studied at the universities of Redlands and Oregon and California Institute of Technology.

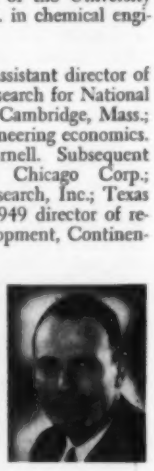
Frank C. Fowler. Petroleum consultant on the staff of Midwest Research Institute. Formerly of the University of Oklahoma faculty. Senior process engineer for Phillips Petroleum Co. from 1943 to 1946.

Kenneth K. Kearby. Senior research associate, Standard Oil Development Co. In recognition of his achievements in the chemistry of synthetic rubber and high octane gasoline. Joined the company in 1937. Graduate of the University of Illinois, Ph.D. in chemical engineering.

Gordon Kiddoo. Assistant director of petrochemical research for National Research Corp., Cambridge, Mass.; in charge of engineering economics. Graduate of Cornell. Subsequent positions with: Chicago Corp.; Hydrocarbon Research, Inc.; Texas Co.; and since 1949 director of research and development, Continental Carbon Co.



G. Kiddoo



R. L. Tracy

Ralph L. Tracy. To manage pilot plant operations at the new Port Jefferson research and development laboratory of John Powell & Co. Formerly: on the research staff of the California Institute of Technology; captain, Chemical Warfare Service; vice president and technical director of Organic Chemicals Corp., Md.; and most recently, chemical engineer in charge of the benzene hexachloride and tetra-

(*Continued*)

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R. Lindley Murray. "Do whatever your chief asks you to do the best you know how. If you do that and keep on doing it the future will take care of itself." That's the advice of the recently elected president of Hooker Electrochemical Co. to young men starting out in the industry. Formerly the company's vice-president of research and development, he says to budding researchers, "You can't kid yourself, you need intellectual integrity or else when you get started down a wrong alley you end in a mess."

These principles have served well for Mr. Murray himself. He started with Hooker in 1916 as a research chemist. His subsequent positions include: plant superintendent, chief engineer, director of development, and a director of the company. During World War II he supervised development of such compounds as: dodecyl mercaptan used in making synthetic rubber; aluminum chloride for synthetic rubber and 100-octane gasoline; hexachloroethane for smoke shells and smoke pots. He was awarded the Jacob F. Schoellkopf Medal for 1949 by the western New York section of ACS in recognition of his engineering ability and able direction of research in the chlorine and alkali industry.

After receiving his chemical engineering degree from Stanford, Mr. Murray participated in all of the more important tennis tournaments during the summer of 1914 and was No. 4 in the national ranking in 1914, 1916 and 1919. He won the national singles tennis championship in 1917 and 1918. Now he is getting "just as much fun out of golf" though he adds that he's not very good.

E. J. Crane. Winner of the Priestly Medal for 1951 awarded by ACS. For the past 37 years, editor of *Chemical Abstracts*. Recipient of the Chemical Industry Medal of the Society of Chemical Industry in 1937. Graduate of Ohio State.

Douglas A. Rogers. Chemical engineer for a new line of evaporators to be manufactured by Rodney Hunt Machine Co., Orange, Mass. Formerly supervisor of research for Lever Bros. Graduate of the University of Washington.

Walter M. Burgess. Manager of the New York chemical department of the chemical division of McKesson & Robbins, Inc. Has been assistant manager.

Henry Howard. Winner of the Perkin Medal for 1951 for 40 years of distinguished service to the chemical industry. Associated with Merrimac Chemical Co. then Grasselli Chemical Co. His contributions include: developments in the production of heavy chemicals particularly sulphuric acid; use of Spanish pyrites as a source of sulphur for chemical purposes; development of the use of bauxite from the British Guiana deposits as a chemical raw material.

Wilbur A. Lazier. New member of the board of directors, Chas. Pfizer & Co. Director of chemical research and development since 1948. For four years previously, first director of Southern Research Institute, Birmingham, Ala. With the chemical department of Du Pont from 1924 to 1944.

John C. Sheehan. Winner of the $1,000 ACS Award in Pure Chemistry, sponsored by Alpha Chi Sigma. Associate professor of organic chemistry at MIT.

Arthur T. Bennett. Manager of operations for the Betania Alkali Plant in Colombia which H. K. Ferguson Co. is building for the Instituto de Fomento Industrial. Veteran of 32 years in the alkali industry: vice president and manager of Baltimore operations for Mathieson Chemical Corp.; previous to that, with Solvay Process Co.

Arno C. Fieldner. Chief fuels technologist, Bureau of Mines. Known for his work in developing techniques for testing and analyzing coal, coke and gas. With the bureau for over 40 years, most recently as chief of the fuels and explosives division. Graduate of Ohio State.

M. F. Browne. New member of the research department, Plaskon Division, Libbey-Owens-Ford Glass Co. To work on glues and industrial resins. Graduate of the University of Illinois, doctorate in organic chemistry from Iowa State.

William E. Harvey. Vice president in charge of production of carbon and graphite products, Speer Carbon Co.; has been plant manager. Prior to that, plant manager of the International Graphite and Electrode Corp., Niagara Falls.

Franklin S. Chance, Jr. Recipient of the first Ph.D. in chemical engi-

(Continued)

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neering conferred by the University of Tennessee. Employers before returning to Tennessee for graduate work: TVA, three years; Du Pont (research engineer), eight years. Now associated with Chas. Pfizer.

Kenneth H. Klipstein has been named deputy director of NPA's chemical division. He's on leave from Calco Chemical Division of American Cyanamid where he's been assistant general manager and head of the technical department. He had particularly good training for his new post from 1941 to 1945 when he organized and managed Cyanamid's priorities and price control department.

He's the son of a chemical pioneer in the U. S. A., Ernest C. Klipstein. So when the young Ken finished a stint in Princeton, which included graduate work in organic synthesis, he joined his father's firm in Charleston, W. Va. Their principal products were anthraquinone, anhydrous aluminum chloride, synthetic aromatics and sulphur colors. He and his brother were managing the family firm in 1933 when they sold out their interests to Calco.

Mr. Klipstein's non-professional activities tend to be artistic and athletic. He's an authority on food and how to cook it with delicacy and finesse. He used to play the saxophone in the Princeton Triangle Club shows. Son David, Princeton 1951, is carrying on the tradition by singing in the Nassoons. That about takes care of the art except for his bridge playing which is unorthodox but definitely good. He likes to gamble at it but has a tough time keeping his winnings down to friendly proportions. As for athletics—while at Princeton he held the course record at the Essex Golf Club of Orange, N. J., with a 68. Recently he won the Fathers and Sons Tournament, with David, at Somerset Hills Golf Club—his swing is still sound and rhythmic. He is a good skeet shot and is very fond of upland bird and migratory bird shooting.

Karl Ellingson. Plant manager of Monsanto's Norfolk, Va., plant; has been assistant plant manager. Started with Monsanto in 1940 as an analytical chemist at the John F. Queeny plant in St. Louis. In 1944, production superintendent of operations at Bahia, Brazil. Graduate of the University of Minnesota.

Alfredo S. Onrubia. Production manager of the new Sharp & Dohme (Philippines) plant now under con-

(*Continued*)

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To further increase the wide range versatility of the well-known Beckman Model B Spectrophotometer, a new Reflectance Accessory is now available for use on opaque, colored samples in solid, liquid or powder form. There are many useful applications for this accessory in the precise evaluation and comparison of color intensities and hues.

For example, diffuse reflectance measurements are useful for accurately controlling the whiteness of talc . . . for controlling artificial coloring of foodstuffs such as butter, catsup, and condensed milk . . . for calculation of dye bath recipes to insure processing . . . for grading the color of paper and the whiteness of flour . . . for matching and controlling shades of powder, rouge and lipstick, paints and inks and many other products where accurate color measurements are essential.

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NAMES IN THE NEWS, *cont. . .*

struction at Manila. Graduate of Ateneo de Manila, 1938; taught chemistry and mathematics there until 1942. Control chemist for Foster-Milburn Co., Buffalo, 1945-1947. Consulting chemist to the Philippine food industry; member of the chemical department, Getz Bros. & Co.

A. T. Look. From head of Dow's extrusion molding section to coordinator of raw materials and plastics production. Joined Dow in 1946. Chemical engineering graduate of Colorado University.

A. T. Look

J. F. Dudley

J. Fred Dudley. Assistant chief engineer, Commercial Solvents Corp., to be located at the Terre Haute, Ind., plant. With the company's engineering division since 1943. Formerly with M. W. Kellogg. Graduate of Virginia Polytech.

Clifford F. Favrot. New member of the board of administrators, Tulane University. Chemical engineering graduate, 1919. President of the Asbestone Corp.

H. S. Reid. Executive vice president, Shawinigan Chemicals Ltd., Montreal, Canada. Studied at McGill. Joined Canadian Electro-Products Co. as research chemist in 1915; was general manager when company became chemicals division of Shawinigan in 1927.

George W. Halek and **George B. Ceresia.** Junior chemists, analytical department, General Aniline & Film Corp., Rensselaer, N. Y., plant. Mr. Halek: studied at Newark College of Engineering, Seton Hall and Maryland University. Mr. Ceresia: chemical trouble shooter, Norfolk Navy Yard; studied at the University of Alabama, Tulane and Purdue.

Frederick Bellinger. Chief of the plants division, Technical Command, Chemical Corps, Army Chemical Center, Md. Formerly professor of chemical engineering at Georgia Tech.

William F. Gianque. Winner of the Williard Gibbs Medal for 1951 conferred by the Chicago section of ACS. Winner of the Nobel Prize in Chemistry for 1949 for his research at low temperatures. Professor at the University of Califorina. First to demonstrate, in 1933, the magnetic method for approaching absolute zero.

Bradley Dewey, Jr. Vice president of Dewey and Almy Chemical Co. in charge of the Cryovac division. Organizer of the company's product development; joined the company in 1945. Graduate of Harvard and MIT.

William P. Gee. Assistant to the president of the Texas Co.; has been vice president of Texaco Development Corp. Studied at the University of Texas and MIT. Joined the Texas Co. in 1927 as a research chemist in the Port Arthur refinery.

A. G. Keating. Production engineer for the NPA. During the last war: head of the WPB regional mining division (California, Arizona and Nevada) and director of the northern California cement industry. Since the war: head of his own engineering consulting service.

William Rand. Retired president of Monsanto Chemical Co., a post he has held since 1945. President of Merrimac Chemical Co. when it was purchased by Monsanto in 1929; became Monsanto vice president. Harvard graduate.

Earl Porter. Chairman of the technical committee, American Pulpwood Assn. With International Paper Co., Mobile, Ala.

Allan W. Low. Engineer of Monsanto's plastics division in Springfield, Mass. With Monsanto since 1948. Previously with General Chemical Division, Allied Chemical and Dye Corp. Graduate of the University of New Hampshire.

Robert C. Becherer. Vice president of Link-Belt Co. Joined Link-Belt in 1923 upon graduation from Purdue. Continues as general manager of the company's Ewart plant, a position he has held since 1947.

Edward J. Matson. Assistant director of research, Abbott Laboratories; has been in the office of the executive director of research since 1945. Research chemist from 1939 to

(Continued)

Designed to handle loads of 500, 1000, or 2000 lbs., the Shepard Niles Lift-About Jr. electric hoist actually exceeds, in performance, that which customarily is expected from these lighter service hoists. And requires less maintenance in doing so.

Two factors are responsible for such outstanding performance: one is a sound engineering background that comes from years of specialized experience. This is apparent in the design and construction of the hoist itself. The other is the Shepard Niles policy of making certain that the hoist you buy is the *right* hoist for *your* service. It is a policy that protects against buying a hoist that is too light for severe service. By the same token, it prevents investing more than necessary when lighter service *is* indicated.

If you would like help with your handling problems, write us. A Shepard Niles specialist will be glad to place our years' of material handling experience at your service.

Shepard Niles

CRANE & HOIST CORPORATION

Makes and sells all three lifting tools for airborne shop loads

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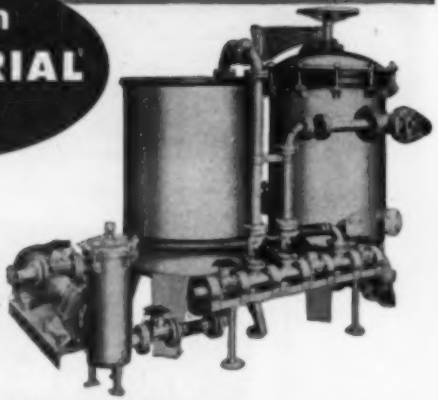
Solution Clarification?

Any Solution—Any Quantity

use an INDUSTRIAL Filter



100 to 15,000 gallons per hour. Portable and stationary models. Standard or special filtration systems engineered to meet unusual requirements.

You save many ways . . .

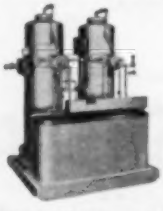
Here's how Industrial filters keep down filtration costs—The flow rates of Industrial filters are based on the solutions involved. You know the capacity you get. With Industrial you get an adequate filter with slurry tank, motor driven pump, valves and fittings in a complete package with one, undivided, experienced responsibility—with space requirements at a minimum.

The labor, down time, and the inconveniences of cleaning, replacing the filter media, and reassembling the filter for every new filter cycle—all are eliminated by the Industrial Air-Wash Cleaning Method available for all models. It is necessary to remove the cover only when new filter cloths are installed.

The engineering, design, and construction of Industrial filters have proved out in long service and low maintenance costs. Industrial has the experience and is large enough to handle your filter requirements. Since 1927 filters and filtration systems have been an important part of our business.

INDUSTRIAL Water Demineralizers

for **Chemically pure water at a few cents per 1000 gallons.**



A Two-Bed INDUSTRIAL Water Demineralizer. Standard two-and four-bed units available with capacities of 200 to 1000 gph. Special units of any capacity engineered to requirements.

Write for full information and recommendations

FILTERS Pressure Type · PUMPS Centrifugal · CORROSION TESTING APPARATUS Salt Fog • Humidity

INDUSTRIAL FILTER & PUMP MFG. CO.

RUBBER DIVISION Vulcanized Linings • Molded Products · WATER DEMINERALIZERS

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NAMES IN THE NEWS, cont. . .

1945. Graduate of the University of Illinois.

Ralph M. Hunter. President of the Electrochemical Society. Manager of the electrochemical division, Dow Chemical Co. Director and president of the Midland Ammonia Co. and director of Dow Chemical of Canada, Ltd. Joined Dow in 1918. Graduate of Case Institute of Technology.

R. M. Hunter

D. B. Keyes

Donald B. Keyes. Advisor to the committee on research, National Association of Manufacturers. Special consultant to Heyden Chemical Corp., New York; recently retired after five years as vice president. Previous experience: chemical engineer for Beckman and Linden Corp., San Francisco; eight years as director of research and development, U. S. Industrial Alcohol and U. S. Industrial Chemical Cos. During last war: director of the office of production research and development of the WPB. Educated at the universities of New Hampshire and California and Columbia.

John V. Freeman. New York consultant on the technological phases of carbonization of coal and coal chemicals. Retired director of the coal chemical sales division, U. S. Steel Co. Started out in 1908 as chief chemist of the central coal research laboratory of the Illinois Steel Co.

Elmer H. Rossin. Technical service manager, textile chemical sales department, Merrimac Division, Monsanto Chemical Co. Joined Monsanto's textile research laboratory, 1943; group leader, 1945. Graduate of the University of Chicago.

Edwin S. Garverich. Manager of technical service, specialty products, Pennsylvania Salt Mfg. Co. His Pennsalt history: joined research and development division in 1929 to work on metal cleaners, Perchloron and fluorine chem-

icals; group leader of laundry and dry cleaning research, 1940; sales division technical advisor on laundry and dry cleaning products, 1945.

William R. Seuren. From assistant to the vice president in charge of Deep Rock Oil Corp.'s manufacturing and research division to supervisor of lubricating oil finishing at the company's Cushing, Okla., refinery. Came to Deep Rock in 1949. Studied at Harvard, Penn State and MIT. Worked for Foster Wheeler, E. B. Badger and Stanolind Oil and Gas Co.

F. Carr Price. Chief engineer, Victor Chemical Works; has been assistant chief since 1943. With Victor since 1920 as operating foreman at Nashville, Tenn.; chief draftsman then plant engineer, Chicago Heights plant. New assistant chief engineer: **Samuel C. Crawford.** Joined Victor in 1928 as design engineer; most recently, assistant chief engineer, general engineering department.

Luther S. Roehm. From assistant general sales manager at Dow to manager of the corn division, A. E. Staley Mfg. Co. A technical and sales executive at Dow for 13 years. Graduate of the University of Indiana, Ph.D. in biochemistry.

C. S. Davis. Plant manager of American Cyanamid's new petroleum cracking catalyst plant at Michigan City, Ind. For the past two years, general superintendent of the company's plant in Marietta, Ohio, where dyestuffs and intermediates for pharmaceuticals are manufactured. Previously with: Chemical Construction Corp., Virginia Chemical Corp. Graduate of Newark College.

C. S. Davis

V. E. Wellman

Victor E. Wellman. Director of process engineering department, Calco Chemical Division, American Cyanamid. Joined Calco in 1945; director of process development for the past two years. Previous jobs: director of purchases for B. F. Good-

(Continued)

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OFFERS THE COMPLETE LINE
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Install Tri-Clover's stainless steel or alloy products in your process lines and realize the advantages of increased production and lower maintenance cost. 32 years of specialized experience in solving corrosion piping problems can be yours by consulting our engineers.
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THE Complete LINE
FABRICATED STAINLESS STEEL INDUSTRIAL FITTINGS AND INDUSTRIAL PUMPS

Washroom walls of KRAFTILE Glazed Structural Wall Units at the Torrance (Calif.) Works, American Radiator & Standard Sanitary Corporation. Prack & Prack, Architects.

Why KRAFTILE Industrial Walls Have So Many Friends...

★ **MANAGEMENT LIKES 'EM** because first cost is the last cost . . . no painting, no plaster-patching. They keep their good looks for the life of the building—at little or no upkeep expense.

★ **WORKERS LIKE 'EM** because they're clean and sanitary, make attractive working surroundings, and provide excellent light reflection.

★ **MAINTENANCE MEN & JANITORS LOVE 'EM** because they are practically mar and scuff-proof; dirt, grease (even lipstick) wipes off with the swipe of a cloth... yet they can be scrubbed daily with washing compounds or disinfectants without dulling their original beauty.

★ **CUSTOMERS AND VISITORS** get a prestige-building impression of KRAFTILE-walled plants and offices, give credit to shrewd management for good sense in selecting wall material that *makes money by saving money* . . . yet provides eye-catching attractiveness in the bargain!

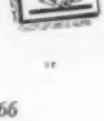
THIS IS A GLAZED STRUCTURAL WALL UNIT—a structural clay tile with a fired-on glazed surface on one or both sides. Available in clear glaze or in attractive colors... a "pre-finished" wall material with these important advantages:

★ **ONE-CRAFT INSTALLATION**—when the mason lays it up, the wall's *finished*—no lathing, plastering, painting!

★ **LIFETIME ATTRACTIVENESS**—never needs painting, can't fade, highly resistant to scratching and scarring. Pencil, crayon, lipstick, grease marks wipe off easily. Unaffected by water, steam, most acids, alkalis.

★ **DESIGNED FOR SIMPLE ERECTION**—wide range of shapes in modular dimensions permits fast installation with minimum of cutting and fitting on the job.

★ **PERMITS STEEL-SAVING REINFORCED MASONRY CONSTRUCTION**—approved installation methods and reinforced masonry will meet earthquake code requirements, use less steel than reinforced concrete!



KRAFTILE CO., Niles, California

( ) *Send my copy of your "Graphic Standards for Glazed Tile"*
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Company _____

Address _____

City _____ State _____

NAMES IN THE NEWS, cont. . .

rich's chemicals division; assistant sales manager, solvents department, R. W. Greeff Co. Graduate of Phillips University.

H. H. Pact. Technical representative for the New England district, Glyco Products Co.—headquarters in Providence, R. I. Formerly with E. F. Drew, Burlington Mills, L. Sonneborn Sons. Studied chemistry at the State College of Vienna, Austria.

Edward W. Comings. Head of the school of chemical and metallurgical engineering and professor of chemical engineering at Purdue. For 15 years past, professor of chemical engineering at the University of Illinois. Has been director of the high pressure laboratory at Illinois and of the Navy and Army chemical corps contracts in chemical engineering. During World War II: Assistant director of the munitions development laboratory there.

Victor E. Wellman and **Charles W. Walton.** New president and vice president, respectively, of Commercial Chemical Development Assn. Mr. Wellman: newly appointed director of Calco's process engineering department, American Cyanamid. Mr. Walton: with Minnesota Mining & Mfg. Co.

Thomas L. McMeekin. Winner of the $1,000 Borden Award in the chemistry of milk presented by ACS. Head of the protein division, U.S. Dept. of Agriculture's Eastern Regional Research Laboratory. Known for his study of protein structure and behavior. Prior to joining the laboratory in 1940: assistant professor of biochemistry at Emory University, chemist with E. R. Squibb & Sons, research associate at Harvard Medical School. Studied at Clemson College and Tulane.

Roy H. Beaton and **W. Kelly Woods.** Assistant managers, Hanford Works Technical Divisions, Richland, Wash. Mr. Beaton: Studied at Northeastern and Yale, Ph.D. in chemical engineering. Spent a year at Du Pont, another at the University of Chicago as a group leader in process research and development for Hanford Works. Head of the separations technology division at Hanford since 1948. Mr. Woods: Studied chemical engineering at Stanford

and MIT, Ph.D 1940. With Du Pont then Hanford (1944). Most recently, head of the pile technology division.

John T. McCabe. Production manager of the liquor subsidiaries of Publicker Industries. Formerly director of quality control. Joined the company in 1930. Studied chemistry at St. Joseph College, Philadelphia.

Katharine B. Blodgett. Received this month the 1951 Francis P. Garvan Medal honoring women in chemistry. Awarded by ACS. First woman research scientist employed by GE's research laboratory (in 1918). Authority on surface chemistry whose findings have led to the development of "invisible" glass and thickness gages which can detect a variation of one millionth of an inch. Worked with Irving Langmuir. Studied at Bryn Mawr, University of Chicago, Cavendish Laboratories at Cambridge, England, under Lord Rutherford.

Walter E. Murray. President of Crown Chemical Corp., Providence, R. I. Has been vice president and general manager, Warwick Chemical Co. Graduate of Providence College.

OBITUARIES

David F. Sirdevan, 78, president of Sirdevan Chemical Engineering Co., Springfield, Ill., died February 9. He was associated with General Chemical Co. for 19 years. He managed West Coast operations and later had charge of all plant operations with offices in New York. He was also associated with Southern Acid and Sulphur Co., St. Louis, and Calco Chemical Co.

Carlisle H. Bibb, 56, vice president in charge of research for Newport Industries, died February 20. With the company for 16 years, he had a prominent role in new process development.

Alvin C. Goetz, 59, manager of the sales service department of the pigment and oxide division, Eagle-Picher Co., died March 21. He had been chief of the protective coatings section of NPA.

Samuel P. Gibson, 52, for the last 13 years manager of the market research division, Commercial Solvents Corp., died in New York April 23. Mr. Gibson was one of the founders of the Chemical Market Research Assn.

A manufacturer requiring good limestone has only to look at Oklahoma - - and he will find what he needs. For limestones are widely distributed over the entire state.

In the Arbuckle Mountains, limestone deposits have a combined thickness of about 8,000 feet (if the dolomites are included). Physically, Oklahoma limestones range from friable or chalky to stone with maximum crushing strength; from coarsely crystalline to very fine-grained; and from minutely oolitic to coarsely pisolitic. Chemically, they range from impure stone suitable for woolrock to chemical grade.

Oklahoma limestone is being utilized extensively for many purposes. Its quality and availability merit consideration for a multitude of additional uses.

TYPICAL ANALYSIS
(26 feet)

	Percent
CaO	54.760
MgO	0.680
SiO_2	0.143
Fe_2O_3	0.074
Al_2O_3	0.174
P_2O_5	0.007
SO_3	0.008
Ignition loss	43.940
Total	99.786

Detailed information on Oklahoma's mineral resources is available on request, based on data by the Oklahoma Geological Survey. Map showing location of mineral deposits is also available.

INDUSTRIAL NOTES

NEW FACILITIES

American-Marietta Co., Chicago—A West Coast plant for the manufacture of specialized industrial paints and lacquers through the acquisition of India Paint and Lacquer Co., Los Angeles.

Laclede-Christy Co. of Pennsylvania—A plant specializing in the manufacture of stiff mud clay refractory brick through the purchase of Paterson Fire Brick Co., Clearfield, Pa.

Sinclair Oil Corp., New York—A research subsidiary, Sinclair Research Laboratories, Inc., with headquarters at Harvey, Ill. E. W. Isom is chairman of the board; P. C. Spencer, president.

Ciba States Ltd.—A new plant at Toms River, N. J., for the manufacture of dyestuffs and other chemicals.

Pennsylvania Salt Mfg. Co.—A new sales department, the industrial chemicals department, combining the former heavy chemicals and special chemicals departments. Albert H. Clem, formerly assistant to the vice president in charge of sales, will head the new department.

International Paper Co.—Additions to its new Natchez, Miss., dissolving pulp mill which will bring its daily capacity to 600 tons, double what it is now. Increased production is scheduled to begin by the fall of 1952.

A. E. Staley Mfg. Co.—Flaking and extraction equipment to be used in modernizing its soybean processing plant at Painesville, Ohio. The new extraction process will embody the use of the Rotocel, a recent Blaw-Knox development, and replace expeller facilities originally installed in 1939.

Dow Chemical Co., Midland, Mich.—A wood preservation laboratory within the biochemical research department. Fred J. Meyer will be in charge.

Sharples Chemicals Inc.—Additions to its alkylamine facilities at Wyandotte, Mich.

Arcos Corp., Philadelphia—Sales office and warehouse in Chicago for its line of stainless, low alloy and nonferrous electrodes. Walter G. List is district manager. Another office and warehouse, headed by B. E. David, has been opened in Los Angeles.

Cutler-Hammer, Inc.—An office in Charlotte, N. C. to handle sales of its motor control and allied electrical apparatus.

VISIrecord, Inc., Long Island City, N. Y.—Mid-Manhattan offices to handle sales of its vertical visible record keeping systems.

NEW REPRESENTATIVES

Warren Steam Pump Co., Warren, Mass., has appointed Harry W. Faunt Le Roy & Associates, Baltimore, as its agents in that area. Betz Engineering Sales Co., New Orleans, has been named to cover Louisiana, Mississippi and Alabama.

Pulva Corp., Perth Amboy, N. J., has appointed the following exclusive sales and service representatives: Harold L. Heakin Co., San Francisco, for northern California territory; King-Gage Engineering Co., Boston, for New England; Process Engineering & Equipment Corp., St. Louis, for Missouri and southern Illinois.

Process Heating, Inc., Brooklyn, N. Y., manufacturers of industrial drying equipment, has appointed Redman Engineering Service, High Point, N. C., as its representative in the Carolinas, Virginia, Georgia and Alabama.

NEW LOCATIONS

Burrell Corp. has moved its offices and laboratories to 2223 Fifth Ave., Pittsburgh, Pa.

Continental Can Co., New York, has moved its Los Angeles sales offices to 1120 Wilshire Blvd.

American Cyanamid Co. will consolidate its four separate offices and four warehouses in the Boston area in a building at 1055 Commonwealth Ave.

Dearborn Chemical Co. has moved to larger offices in the Chicago Merchandise Mart. The company's main factory and laboratory remain at 1029 West 35th St., Chicago.

United States Steel Co. has moved the headquarters of its coal chemical sales division from New York to 525 William Penn Place Bldg., Pittsburgh, Pa. A district sales office will be maintained in New York at 71 Broadway.

NEW COMPANIES

Walter N. White and **William F. Guyton**, consulting ground water hydrologists, to open offices in Austin, Tex., and Silver Spring, Md. Former U. S. Geological Survey specialists, they will continue work on the evaluation of available supplies of both ground and surface water for industry.

Allied Metal Specialties, Inc., Baltimore, to design and fabricate all types of special fixtures from any metal or alloy. President is R. E. Lee Mowbray. Company will specialize in equipment for high temperature and corrosive applications.

Cambridge Corp., Syracuse, N. Y., to manufacture an air filter first used by the AEC to keep radioactive particles out of the atmosphere. Company is jointly owned by Arthur D. Little, Inc., and Carrier Corp.

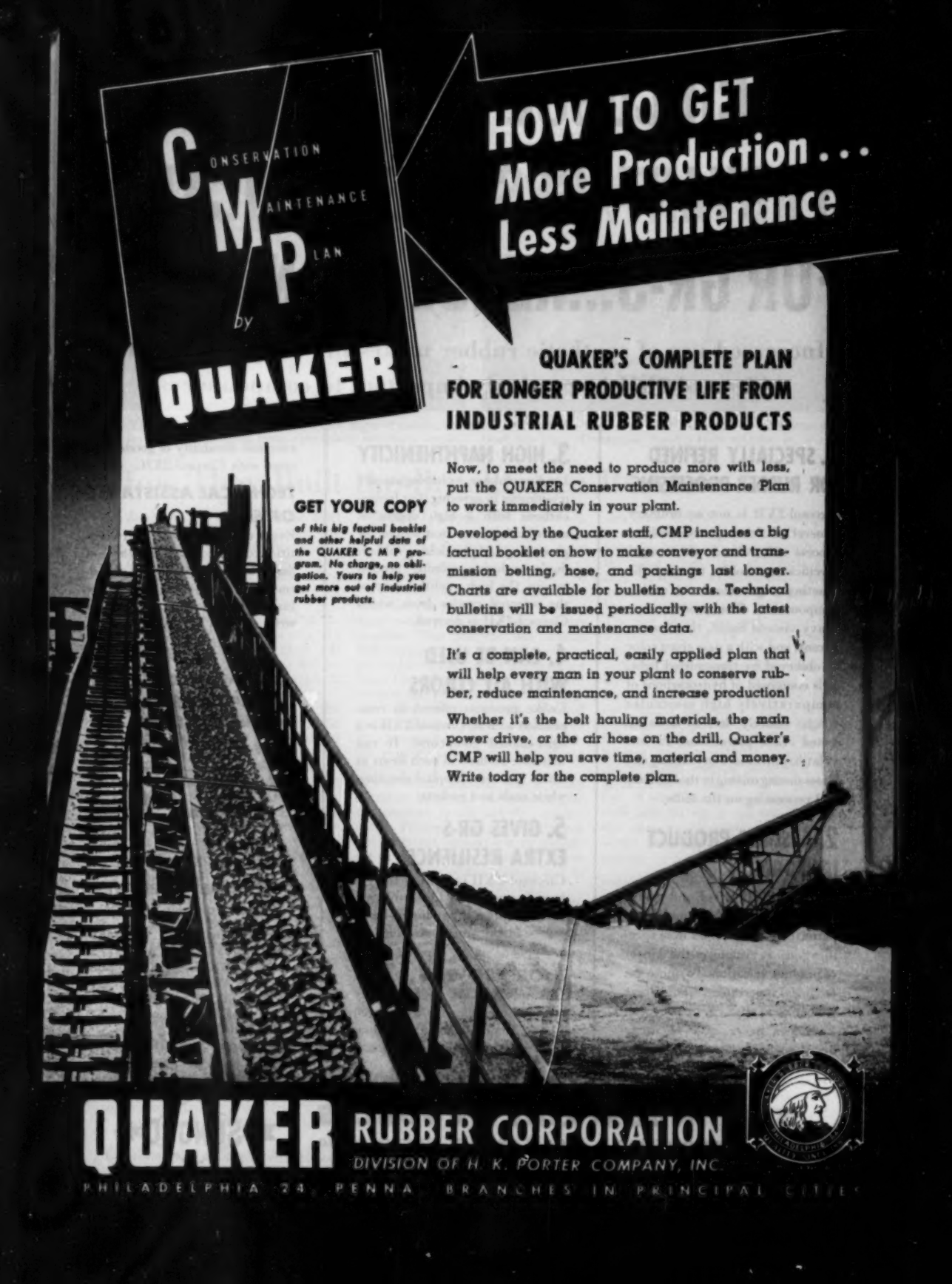
Chemit—Industry's Chemical Workshop, Brooklyn, N. Y., non-specialized consultants, to concentrate on product development and utilization. Company has been formed by Leon Sternberg.

Mallory-Sharon Titanium Corp., Indianapolis, Ind., to develop, produce and market titanium and titanium alloys. The company is a joint venture of P. R. Mallory & Co., Indianapolis, and the Sharon Steel Corp., Sharon, Pa.

Bronze Bearings, Inc., Cranford, N. J., to take over the manufacture and sale of bronze bearings, bushings, graphited oil-less bearing, and nonferrous castings formerly produced by S & H Bearing Mfg. Co., Cranford.

NEW LINES

Scott & Williams, Inc.—A hydraulic pump invented by Lindsay H. Browne through an agreement giving the company exclusive right to manufacture, distribution and sales.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Conservation
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Plan
by
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More Production . . .
Less Maintenance
QUAKER'S COMPLETE PLAN
FOR LONGER PRODUCTIVE LIFE FROM
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Now, to meet the need to produce more with less, put the QUAKER Conservation Maintenance Plan to work immediately in your plant.
Developed by the Quaker staff, CMP includes a big factual booklet on how to make conveyor and transmission belting, hose, and packings last longer. Charts are available for bulletin boards. Technical bulletins will be issued periodically with the latest conservation and maintenance data.
It's a complete, practical, easily applied plan that will help every man in your plant to conserve rubber, reduce maintenance, and increase production!
Whether it's the belt hauling materials, the main power drive, or the air hose on the drill, Quaker's CMP will help you save time, material and money. Write today for the complete plan.
GET YOUR COPY
of this big factual booklet and other helpful data of the QUAKER C M P program. No charge, no obligation. Yours to help you get more out of industrial rubber products.
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QED, cont. . .

Total settlement, as well as differential settlement or tilting, had to be predicted and compensated for in advance. Prior to the start of detailed design, borings and load tests were made to determine the elastic properties and the load settlement characteristics of the sub-soil after the over-burden was removed. (The foundation extends 35 ft. below the surface.) The predicted total settlement was of the order of 2 in., and actual total settlement was 1¼ in. when measurements could no longer be made. This was compensated for at the elevation where the base for the actual pile structure was laid by correcting for tilting and by building the base higher by the amount of the additional settlement to be expected.

The total settlement in sand takes place during construction when the loading of the base is complete; therefore, the predicted and actual settlement were within the desired tolerances. Since the base was sand, there was no plastic flow of the soil to contend with.

The entire structure was also designed to withstand earthquake shock.

FBI OK

Clearance of personnel assigned to classified work took three months of checking by the FBI. Security also affected the handling of materials. A special type of concrete was used in the pile shield. The contents of this mix are classified. It was necessary, therefore, to set up two separate batch plants to furnish the 29,000 cu. yd. of concrete required. One batch plant was operated on a conventional basis. The other was operated under security conditions and was under guard as long as it was in use. Even overages and wastes from the classified plant were destroyed under security regulations.

From the H. K. Ferguson Co., W. N. Thompson vice-president in charge of Eastern district.

LIGNIN

. . . *Replacement for Carbon Black*

J. J. Keilen

It has been found that lignin can replace carbon black in some applications of rubber compounding. Lignin-rubber products, made on an experimental scale and tested, have shown properties just as good as, and in some cases better than, those made with rubber and carbon black.

Lignin, now a waste product, is available to meet more than twice the present needs for carbon black. However, more study is needed before the lignin will be able to replace carbon black for tire use.

J. J. Keilen, Polytechnic Institute of Brooklyn, before the American Chemical Soc.

"When you change your job, why should you be penalized by losing accrued pension rights?"

—Adolph A. Berle, Jr.

Industrywide Pension Plans

Pension plans negotiated between company management and labor unions should be interchangeable so workers will not be penalized for moving from one job to another.

We seem to be committed to helping out social security by private business plans either put into effect by enlightened corporation management, or negotiated between corporate management and labor unions. This is all to the good, but these individual funds have one major technical difficulty.

The employee cannot leave his job and take another one without substantial loss of pension fund rights. Yet mobility of employment is a part of freedom. It should be financially possible to work out a plan by which rights in pension trusts shall be interchangeable. Such plans are already in existence in some places.

It should be possible to work out a uniform pension trust form so that a man who leaves his job with the "Atlantic Corp." and takes a job with the "Pacific Corp." can transfer contributions from one fund to the other without substantial loss. If this can be worked out, a solid contribution will have been made toward combining individual security and individual freedom.

If any pension plan or old age security payment is to be successful a stable dollar will have to be maintained and there will have to be a general level of stabilized prosperity.

No individual can be responsible for huge economic swings such as affect great industries and great corporations. He is there in the grip of big organization just as the big corporation is in the grip of general economics, and the collective action through social security and pension funds is the only possible attack.

Adolph A. Berle, Jr., American Molasses Co., before the Research Council for Economic Security, Chicago, Feb. 26, 1951.

FLUORIDATION

. . . *New, Safer Chemical*

Wayne E. White

Safer, more economical fluoridation of municipal water supplies for the prevention of dental decay is promised by a self-policing new chemical.

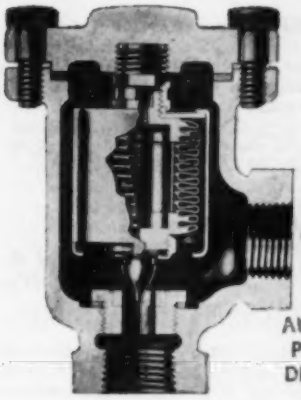
The new substance, called Flural, is much less poisonous than the fluoridating agents now in use, and therefore can be handled by water plant personnel with much less danger. None of the agents presents any hazard to the water consumer, because they are so greatly diluted by the time they pass through the reservoirs and come out of the tap.

Flural is self-policing in the sense that it will release fluorine to the water only so long as the concentration of the anti-dental-decay element is below a certain safe maximum. If the water has a fluorine content of more than about 1.5 parts per million, however, the Flural will reverse its action and begin to remove the fluorine.

Flural is a fluorine-containing alum complex which is readily soluble in water. Its low toxicity is of great importance to water plant personnel who must handle large amounts of the fluorine compounds.

No special equipment is required for Flural, in contrast to the use of sodium fluoride, hydrofluoric acid, and the other fluoridating compounds now employed or being considered for use. Because of the poisonous nature of these other compounds and because of the necessity for very careful control in amounts of them to be added, special dust-tight, carefully calibrated feeding equipment is necessary. Flural, on the other hand, can be fed into the water by means of the equipment now used by many cities to add alum to aid in clarifying the water. The chemical gives the same action as alum, and in addition, introduces fluoride into the water. The fact that new equipment is not neces-

(*Continued*)



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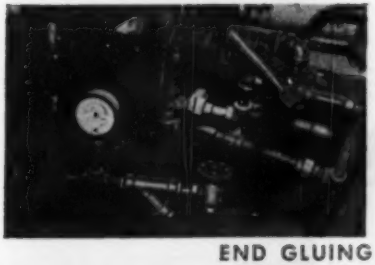
AUTO PAINT DRYING

. . . AND STEAM ECONOMY

SARCO No. 9 THERMOSTATIC STEAM TRAP

The hours of waiting in the morning for steam equipment to warm up can be reduced to minutes with the Sarco No. 9 thermostatic steam trap. It is wide open when cold. All air and condensate pass quickly. Then, during normal operation, condensate is discharged at a temperature within 10°F of that of the steam. This has given the trap double its former capacity. No seat changes are required for varying pressures within the range of each type from 0 to 300 p.s.i.



END GLUING

BOTTLE WASHING

PUT ONE ON EACH COIL

This trap is so inexpensive that one can be placed on each coil or jacket and thus save enough in fuel and increased production to pay for the hook-up in a short time. The Sarco No. 9 is used extensively for process tanks, steam lines, radiators and wall coils, tracer lines and outdoor applications of all kinds. Ask for Catalog No. 250-A.

314

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From mammoth conveyor ovens for high production to the smallest of laboratory units, KIRK & BLUM builds many types of industrial ovens for a multitude of uses.

Illustrated are several small "lab" ovens used for research and test purposes, as well as for limited production. Ovens are electrically heated and provided with complete controls and safety equipment.

Typical installations are shown in "Industrial Ovens" Booklet. Write for your copy today.

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sary will help keep the cost of fluoridation low when the new compound is used.

Wayne E. White, Ozark-Mahoning Co., before the 119th national meeting of the American Chemical Soc., Boston, April 4, 1951.

SALARIES

. . . Of Chemical & Engineering PhD's

M. H. Trytten & Theresa R. Shapiro

Some interesting information on the earnings of PhD's was collected for the 1949 edition of *American Men of Science*. Although not the most up-to-date statistics, the abstracted tables appearing below, should prove useful and valuable.

M. H. Trytten, National Academy of Sciences, and Theresa R. Shapiro, U. S. Dept. of Labor.

Where Do Chemical & Engineering PhD's Work?*

	Chemistry	All Engineering
Industry	49.1%	43.6%
Education	30.2	20.1
Government	7.0	7.7
Other†	13.7	28.6

* Includes a highly selected group of scientists with bachelor's degrees equal to the PhD's in scientific achievement.

† Includes those chemists and engineers working for both education and government; foundations; as independent consultants; for education combined with consulting; and a small proportion that fell into none of these classes.

Median Earnings and Ages

Chemistry	All Engineering
Industry Age 37, $6,880	Industry Age 39, $8,000
Government Age 41, 6,290	Government Age 42, 7,400
Education Age 39, 4,670	Education Age 42, 5,700

Earnings of All Scientists* by Regions

	Industry	Government	Education
Middle Atlantic	$7,320	$6,730	$4,930
South	7,240	5,960	4,700
North Central	6,940	5,750	5,070
Pacific	6,630	6,050	4,940
New England	6,500	5,410	4,730
Mountain & Plain	6,500	5,810	4,030

* These figures were compiled for all scientists working for all types of employers and all combinations of types.

GRINDING MILLS

. . . A New Concept

A. W. Fahrenwald

Increase the specific gravity of the tumbling units in a ball (or tumbling) mill and you increase the capacity of the mill. That's a well known fact.

If, then, a grinding medium heavier than steel balls can be found, the grinding rate (capacity) of a mill may be expected to increase proportionately. Tungsten carbide balls with a specific gravity of 14, will

fill the bill. But these are too costly.

Another way to utilize the principle is to use centrifugal force.

With this in mind, an experimental ball mill was constructed. This mill, as a unit, is swung in a circle, i.e., in an orbit, while it is simultaneously rotated on its own axis ball-mill wise. Using such a machine, a series of tests was made in which the time of grind was the variable. It was found that the centrifugal mill grinds nearly four times as fast as the same mill operated as a gravity mill. With larger mills and higher orbital speeds, a potency as high as eight times that of the gravity mill was achieved.

Although two patents have been issued, centrifugal mills have not come into commercial use. Two good reasons are given for this: (1) the floor space per unit of mill volume is large, and (2) the feeding and discharging presents severe problems.

Rock Products, Feb., 1951, pp. 93-97.

ELECTRONIC HEAT

. . . *Hardens Steel Parts*

A unique electronic method for hardening steel, developed during World War II, has been adapted to hardening the starter ring gear of an automobile.

The new technique does in 20 sec., a job that required more than 2 hr. by the older method.

Through electronics, heated areas now can be confined to thousandths of an inch. This permits hardening of metal parts with the same precision that they are machined.

In processing, the gear is mounted on a holding fixture surrounded by a water-cooled electric coil, which reverses its magnetic field some 540,000 times a second. This sets up a

(*Continued*)

If your processing includes

Polymerization–
hydrogenation–
oxidation–
chlorination–

or other chemical reactions

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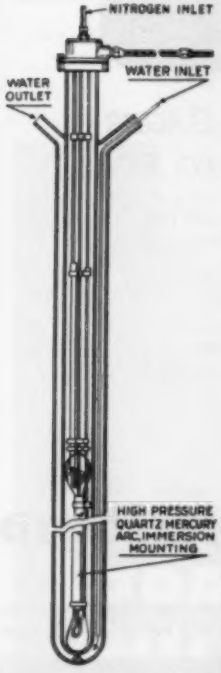

Experience from pilot to full plant operation has proved that in many instances the use of ULTRAVIOLET RADIATION will give better and more economical results than other chemical processing methods needing more time, more labor and more equipment.

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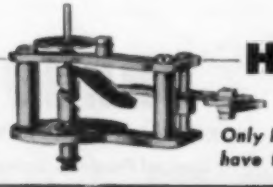

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QED, cont. . .

molecular agitation in the steel that generates intense heat as it quickly works inward.

Within 13 sec. the gear teeth are brought to the specified heat; 7 sec. are required for quenching.

The coils can be located right on the production line in proper manufacturing sequence, eliminating the handling formerly required to move the parts to ovens for case hardening.

From *Automobile Facts*.

LIQUID OZONE

. . . *Taming a Wildcat*

Clark E. Thorp

By successfully taming concentrated liquid ozone, scientists have developed a fuel that may someday send rockets to the moon.

Recent advances at Armour Research Foundation of Illinois Institute of Technology prove that concentrated liquid ozone, a beautiful dark blue substance, can be handled safely.

More than just a rocket fuel, ozone has other valuable military and commercial applications. It can be decomposed directly to oxygen for submarine patrols and high altitude flying and is an ideal agent for water purification, air purification, and bleaching.

By demonstrating that ozone may be safely manufactured, scientists at the foundation have opened the door for possible tonnage production.

Scientists have used fluorine, another powerful chemical, as an experimental rocket fuel. Although experiments with fluorine will continue, liquid ozone, which is practically as powerful, may provide the eventual solution.

During World War II, the Germans worked overtime on an ozone-propelled rocket designed to bombard New York City from launching platforms over 4,000 mi. away. Luckily, they were unable to discover the secret of handling liquid ozone without spontaneous detonation. Otherwise, residents of that area might have had front-row seats for a preview of guided missile warfare.

By replacing oxygen tanks with containers of liquid ozone, both planes and submarines would gain additional space with no sacrifice in oxygen volume.

Oxygen containing ozone gives off more usable oxygen per unit volume.

Used for water purification, ozone is a powerful chemical that literally

"burns up" impurities without leaving an unpleasant taste. Large cities, such as Philadelphia and Paris, and smaller communities including Whiting and Hobart, Ind., have used ozone water purification systems for years.

An excellent deodorizing agent, dilute solutions of ozone in ventilating systems will overpower the smell of fish oils and rancid fats.

As a bleaching agent, ozone is superior to chlorine, hydrogen peroxide, and other liquid bleaches as it leaves no detrimental residue which ultimately decreases the strength of the bleached material.

Already in use in Europe as a bleaching agent, ozone works on paper, pulp, blood, starches, and oils. It has also been used for oxidizing oils in the manufacture of linoleum.

Ozone can readily be made by bombarding oxygen with high speed electrons. [See *Chemical Engineering*'s Pictured Flowsheet, Nov. 1949, p. 168.] This technique duplicates nature's own method and explains why ozone can be smelled in the air immediately after a summer thundershower.

Until two years ago, ozone studies were as dangerous as they were interesting. Laboratories used to have about one unscheduled explosion per day until scientists learned that ozone could be made to behave by removing certain thermal, mechanical, electrical and chemical sensitizing influences.

Today, planned explosions rock the laboratory as tiny drops of ozone are set off by remote control. Aluminum cups are mutilated by a drop of liquid ozone no bigger than the head of a pin.

Clark E. Thorp, Armour Research Foundation, before the Electrochemical Society, Washington, April 4, 1951.

COATINGS

. . . *New Testing Concept*

Henry Grinsfelder

Approximately one billion square feet of metal is coated in the U. S. every month with surface coatings which include nitrogen-containing resins. The most common use of such coatings is as "appliance whites"—a term used to describe the enamel on a wide variety of household items.

Our research has revealed that failure of baked enamels to adhere to metal under exposure to water, soap, or humid atmospheres may be the principal factor causing blistering of the finishes in service.

Final tests for strength of the

(Continued)

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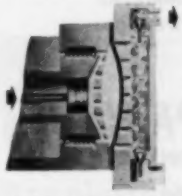

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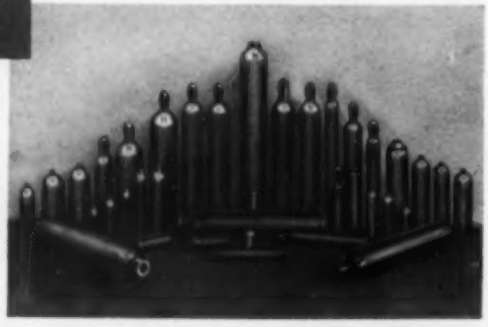

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enamel coatings and their resistance to cold water, hot water, soap, water vapor, or steam were made on the enamel film itself, without any metal under it. This feat was accomplished by enameling sheets of tin-plated steel and then softening the tin by using mercury, which forms an amalgam with the tin. If this is done properly, the enamel coating can be stripped off, and tensile strength under wet and dry conditions, as well as resistance to the passage of water or vapor, can readily be determined.

This is one of the early uses of free film studies for baked finishes, and from the results obtained appears to be an unusually effective method for use in future investigations.

Nitrogen containing resins are used in the enamels to give faster baking speed, better color, and improved resistance to alkalis. In many, if not all, of the items decorated with the baked white enamel, water, water vapor, or steam is a frequent source of early coating failure. The problem is to obtain in the finish—without too high a cost—the desired gloss, adhesion to metal, and water resistance.

Three items stand out in the result of this study. One is that the baked finishes as films are vastly different and much weaker when wet than when dry. For example, one film that had a tensile strength of 1,700 psi. when dry tested about 20 psi. when wet. In addition to loss of adhesion when wet, other film properties, such as flexibility and tear strength, were altered in a similar manner. These properties recover, however, on redrying, while adhesion does not.

A study of pigment effect was also made, as was a detailed study of various baking schedules and inclusion of zinc oxide as a portion of the pigment. Unexpectedly, 5 percent zinc oxide was found to be a powerful fortifier.

Henry Grinsfelder, Rohm & Haas Co., before the national meeting of the American Chemical Society, Boston, April 4, 1951.

QUARTERMASTER NEEDS

. . . *Fuel Tablet*

Warren Stubblebine

We have been working for several years on a fuel tablet made of trioxane. This fuel tablet is used for heating individual rations in the field. Though not perfect, it yielded an adequate supply of heat, burned with a fairly non-luminous flame, ignited

readily under adverse conditions, and, if packaged properly, was stable for several years. We conducted tests on the tablets and found them reasonably satisfactory. Several months ago we decided that the item should be included in our individual combat rations replacing the old metaldehyde hexamine, solidified alcohol and wax types. Unfortunately, however, there was but one producer and his plant, far below our capacity requirements, was due for dismantling. It was necessary for us therefore, to take a less satisfactory item which might present some toxicity problems in the field because if it is burned with limited air supply, the gaseous products are poisonous.

We are now in the course of a development problem with a new fuel tablet which we call DIPC. It is diisopropylidene glyoxal. It overcomes many of the disadvantages of even trioxane. However, it has not been made commercially and we are now studying methods of synthesis so that it can be produced readily and economically. The new materials for the synthesis are tetrachloroethane, acetone and fuming sulphuric acid, all cheap and readily available. An expensive reagent is used as the catalyst in one step of synthesis and as a result, the ultimate cost of the tablet may be higher than anticipated. We hope to be able to recover a part of the catalyst but that is the problem we have. We need a cheap method of preparation, suitable for manufacturing purposes of diisopropylidene glyoxal.

If anyone has any ideas to contribute on this one, the Corps would appreciate it.

. . . *Insect Repellent*

We are also interested in obtaining an insect repellent which a man can rub on himself and will give continued protection for periods up to 24 hr. We think we have the repellents which will perform the repelling action against the insects but they are effective for only 2-3 hr. at the most.

. . . *Textile Flameproofer*

We have been and probably always will be interested in flameproofing agents for textile materials. On the face of it, of course, to render an organic compound completely unaffected by high temperatures is a seemingly impossible problem. But the incidence of fire in textiles can be reduced. Our present flameproofing compounds—the chlorinated compounds together with antimony oxide—are fairly effective but the add-on—the increase in weight is a serious disadvantage. We increase the weight

(Continued)

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The above pictured unit is 108" I.D. x 126' 0" long on the straight, weighing approximately 70 tons. The vessel was constructed of Carbon Steel to the requirements of the API-ASME Code; all seams being X-RAYED at their intersections. This vessel was loaded on two 50' 0" and one 42' 0" flat R.R. cars.

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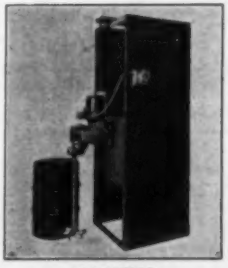

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of a tent by at least 50 percent in order to do it. It cannot be used on clothing as such because of toxicity problems. It presents corrosion and degradation problems when metal parts of the tent are left in contact with the treated fabric. Ideally we need a compound which will have very little "add-on," does not affect the hand or feel of the fabric, will not flame, will not have any after glow and one which will be resistant to weathering.

. . . *Fungicide*

We have been searching for the past two years for an agent—call it fungicidal or bactericidal—which will inhibit growth of microorganisms on coated fabrics, particularly those made from plasticized vinyl resins and still present no toxicity problem to the individual wearing the items.

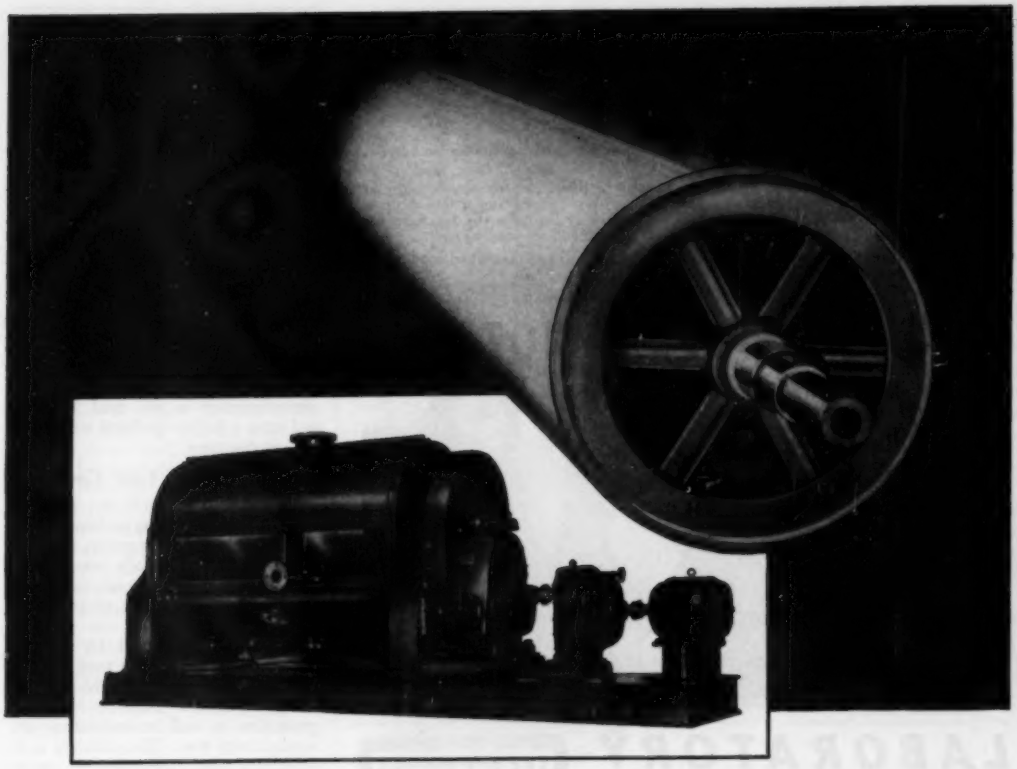
. . . *Portable Heaters*

Another specific problem we have is to find a means of providing supplemental heat to the extremities in extremely cold climates. An electrical gadget operating on batteries sounds like a solution except that batteries are not very effective under Arctic conditions. At least, not in sizes sufficiently small that they can be carried readily. The complicated device must be able to be carried by the individual, light in weight, operating on common, available fuels, and provide heat for a period of perhaps 4 hr. minimum. In addition, it should be readily ignitable and its products should be non-toxic. It will be used to provide warmth for hands and feet of soldiers on patrol, and for sentries. Another contemplated use is to provide heat in a bag for the evacuation of casualties in the Arctic. We have considered the flameless combustion of gasoline on platinized asbestos gauze in a small device, but it has been only partially satisfactory. Bottled compressed gases, like the French propane lighters, have also been considered but the weight per unit of heat is excessive and the devices are not trouble-free. It is a problem that will require a great deal of ingenuity to solve.

. . . *Non-Toxic Plasticizer*

With the present shortage of polyethylene, it is becoming increasingly apparent that more work should be done on a plasticizer for vinyl films which will permit their use in food packaging. Some of the newer Saran films may help but with the productive capacity for the basic resin and

(*Continued*)



New Design Flaker Shaves Production Costs

Production of a new insecticide required high output with close control of temperatures, and protection of product to maintain quality. To solve the manufacturer's problem, Lukenweld designed and built a single-roll flaker.

This unit with nickel-clad steel steam jacketed dip pan and solid nickel agitators holds and protects the molten material which rapidly crystallizes on a chrome-plated jacketed steel roll through which water circulates. Crystallized material is then scraped off by a doctor knife. Fast flaking under carefully controlled temperature, and prevention of metallic pick-up assure a quality product. Complete success of the first installation resulted in additional units being ordered.

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WARREN G. STUBBLEBINE,
Research Director,
Quartermaster General's Office

QED, cont. . .

the film as well, it would seem that increased work on plasticizers which can meet Pure Food and Drug Administration requirements for food packaging is in order. There is but one plasticizer in this field that has had even a highly qualified consideration at this time.

. . . Can Coatings

In the field of protective coatings we have two important problems. One is to provide a coating system for food cans—perhaps eventually interior and exterior which will permit us to use cans made from black plate rather than tin plate. With tin supplies short and the demand for canned rations as well as civilian food becoming greater, the work in this field is being expedited. Exterior corrosion protection as well as camouflage are needed even now. The problem is to develop a rapid drying, tough, corrosion resistant coating of good camouflage properties. The other is an interior coating for gasoline cans—the 5-gal. can with which you are familiar. Here the need is for a coating which will be unaffected by water or gasoline and will be sufficiently flexible and tough under climatic extremes so that rough handling, denting and subsequent reclaiming will not damage it. Because it must be applied after the can is fabricated the problem becomes a little more difficult since it would appear that only a slush type coating composition can be used. Ideas are needed on this one, if we are to find a solution.

. . . Synthetic Tannins

We are interested too, in synthetic tanning agents. Quebracho and other natural tannins are in short supply and a good, all-around synthetic tanning agent is necessary. We are evaluating one available synthetic material at the present. We do not know at this stage just how effective it is under all possible conditions but again with only one such material available we may find ourselves in the same position with it as with the natural tannins in the event of an emergency. Our interest here lies in not

only leather for uppers, but for soles and gloves as well.

Warren Stubblebine, Office of the Quartermaster General, before the Commercial Chemical Development Association, Washington, Oct. 3, 1950.

NAVY NEEDS

. . . *Can You Supply?*

T. A. Solberg

One of the chemical problems with which we are confronted consists of improving present techniques and methods.

As examples, we have such problems as the provision of hydraulic fluids with materially reduced flammability and better viscosity characteristics than those now available. Another case would be the development of propellants with improved characteristics of power, liner erosion and wear.

Another example is the need for more efficient corrosion inhibitors. Research on the absorption by metals of polar organic compounds indicates that, in general, the amount of chemisorption on steel decreases in the relative order: acids, amines, alcohols, esters. This may be a guide for the development of suitable rust-resistant compounds. Thus, studies at the Naval Research Laboratory indicate that phenyl stearic acid is a superior corrosion inhibitor. Protective coatings for supersonic aircraft are also vitally needed. The main problem here is adhesion of the coating to aluminum or magnesium under the conditions found in supersonic flight.

A related problem is the prevention of oxidation in lubricating oils. Effective anti-oxidants are required for this purpose. This is becoming increasingly important because of the higher operating temperatures of some of our engines. Many classes of inhibitors have been considered or used for this purpose, especially phenols, amines, sulphides, and selenides.

We are not completely satisfied with these types. We want better ones if we can get them. Recent research has led to the development of heterocyclic compounds such as phenothiazine as an antioxidant. Certain derivatives of phenothiazine such as 2-trifluoromethyl phenothiazine also appear to be very efficient antioxidants. Further research and development could well yield other heterocyclic compounds with optimum properties.

A continuous concern of the Navy has been the hazard to ships and planes from highly flammable lubricants and hydraulic fluids. We are

(Continued)

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The 250-ton-per-day Soybean Extraction Plant of The Glidden Company, located at Indianapolis. The products produced here are degummed and non-degummed soybean oil and 4-Hi Meal.

The Glidden Company has assumed a leading role in the nation's food, paint and chemical industries and today operates 37 plants and two mines in 25 communities. Visualizing the soybean as a vastly important source of raw materials for food, feed, paint and chemicals, Glidden established soybean research and processing plants at Chicago and Indianapolis.

Important in soybean processing is the elimination of the dust problem. For this purpose Glidden chose **DAY** Dust Control systems with highly efficient **DAY** Type "AC" Dust Filters.

6 FILTERS, 4 COMPLETE SYSTEMS INSTALLED IN INDIANAPOLIS PLANT

System one includes one **DAY** Type "AC" Dust Filter installed on the pulverizer grinding system used for grinding toasted flakes into meal.

System two combines two **DAY** Type "AC" Dust Filters operated in parallel for dust control on the bean preparation operations, including de-hulling and the collecting of dust off the flakes before they are transmitted to extraction.

System three consists of the extraction filters. Two **DAY** Type "AC" Dust Filters are connected in parallel and recover dust from the hull cyclone and the meal cooler cyclone.

System four utilizes one large **DAY** Type "AC" Dust Filter which is divided into two sections and located on the track shed roof. Section one collects dust from the bulk meal car loading system; section two collects dust from the grain unloading operations at the elevator.

DAY CAN SOLVE YOUR DUST PROBLEM

Since 1881, The **DAY** Company has specialized in engineering, manufacturing and installing dust control systems. **DAY** engineers are ready to serve you efficiently and economically regardless of the dust situation in your plant.

For complete information about **DAY** Dust Control Systems and the **DAY** Type "AC" Dust Filter, Write-to-**DAY**.

DAY SINCE 1881

The **DAY** *Company*

856 3rd Ave. N. E., Minneapolis 13, Minn.
IN CANADA: P. O. BOX 709, FORT WILLIAM, ONTARIO
BRANCH PLANTS IN FT. WORTH, BUFFALO AND WELLAND, ONTARIO

QED, cont. . .

naturally quite interested in any development which tends to reduce this hazard. The properties of the methyl and phenyl silicones are well known. Less common, but equally important, are the diester fluids, fluorolubes and stable alkyl phosphonates. We are particularly proud of the Navy's development of the hydrolubes as a hydraulic fluid. This is a water base-polymer thickened fluid especially suitable for aircraft. We anticipate a large naval requirement for diester fluids, such as di-2-ethyl hexyl sebacate, for special uses as instrument oils. If these fluids could be made cheap enough, large volume uses in aircraft can be foreseen. Development of perfluorosilicones would be of interest if they could be prepared.

T. A. Solberg, United States Navy, before the joint Chemical Market Research Association, and the Commercial Chemical Development Association, Washington, Oct. 4, 1950.

TWELVE COMMANDMENTS

. . . *Of Marketing Research*

Vergil D. Reed

1. There is nothing magical about marketing research, it's merely finding the facts and organizing them in such a way that sound conclusions can be drawn from them.
2. Choose the person or concern carefully to do your research, then entrust the procedures to them.
3. Divorce your research department from promotion so it can do an objective and thorough job. Put your research director (your navigator) close to the pilot's seat. There is little excuse for dangerous blind flying by today's executives.
4. Don't fence your research in, let it go where the facts lead.
5. Stress trends and changes, and their implications.
6. Don't rush into expensive field investigations until you have exhausted the possibilities of the pantry. The wealth of facts already available but which are constantly ignored is a shocking waste. Never undertake original investigations until all these sources have been exhausted. You can often find the answers without going into the field.
7. Good wine and good research can't be hurried.
8. Shoot at birds—not flocks. You can't get all the answers in one survey.
9. Insist on reports which are simple and clear, with definite conclusions and recommendations.

(*Continued*)

An Invitation to Every American Who Has an Idea for a Better Petroleum Product

To encourage progress, The Sinclair Plan will open the doors of the company's great petroleum laboratories to the best ideas of inventors everywhere.

INVENTIVE Americans are often hamstrung today. Not because of any lack of ideas, but because of a need for large and expensive facilities to find out if and how their ideas work.

This was no obstacle in our earlier days. With nothing but his own hands and a few dollars, Henry Ford proved that he could build an automobile that ran. Eli Whitney built his cotton gin in a barnyard with homemade tools—and it worked.

In contrast, the first pair of nylon stockings took ten years of research time and $70,000,000.

Today, science and invention have become so complex that a man with an idea for a better product often needs the assistance of an army of specialists and millions worth of equipment to prove his idea has commercial value.

Within the petroleum field, The Sinclair Plan now offers to provide that assistance.

The Sinclair Plan

Under this Plan, Sinclair is opening up its great research laboratories at Harvey, Illinois, to independent inventors who have sufficiently good ideas for better petroleum products.

Sinclair Research Laboratories have nine modern buildings equipped to handle every phase of petroleum research. These laboratories were built with an eye to the future, and their potential capacity is larger than is required for current work. This capacity will be made available for developing the best ideas of outside inventors.

If you have an idea for a better petroleum product or for a new application of a petroleum product, you are invited to submit it to the Sinclair Research Laboratories, with the provision that each idea must first be protected, in your own interest, by a patent application, or a patent.

If the directors of the laboratories select your idea for development, they will make, in most cases, a very simple deal with you: In return for the laboratories' investment of time, facilities, money and personnel, Sinclair will receive the privilege of using the idea free from royalties. This in no way hinders the inventor from selling his idea to other companies or from making any kind of arrangements he wishes without further reference to Sinclair.

How to Participate

Instructions on how and where to submit ideas under The Sinclair Plan are contained in an Inventor's Booklet that is available on request. Write to: Executive Vice-President, Sinclair Research Laboratories, Inc., 630 Fifth Avenue, New York 20, N. Y. for your copy of this booklet. *Important:* Please do not send in any ideas until you have sent for and received the instructions.

SINCLAIR—A Great Name in Oil

SINCLAIR RESEARCH LABORATORIES at Harvey, Illinois, have contributed many of today's most important developments in the field of petroleum. Under The Sinclair Plan, the available capacity of these laboratories is being turned over to developing the promising ideas of inventors everywhere.

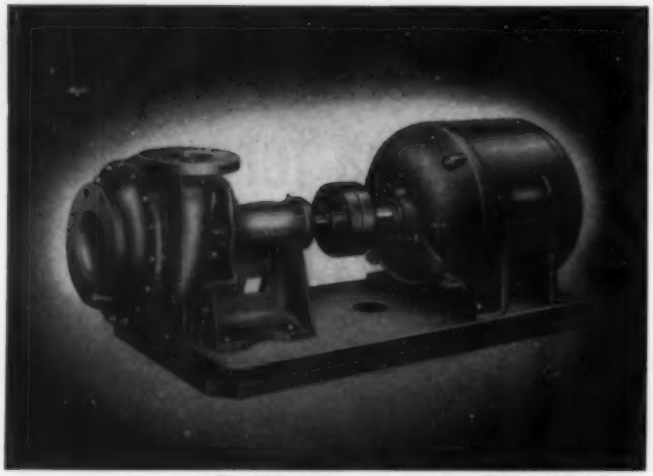

Fig. 3169 single stage, open impeller centrifugal

Goulds *New Design*

gives carefree pumping efficiency for the long pull

The 3169 is one of the latest designs to come off Goulds drawing board. It takes every advantage of modern hydraulic design—and it is thoroughly tested and proven for economy and dependability.

With the 3169 you get tremendous versatility with high operating efficiency and relatively low power consumption.

REAL "JACK-OF-ALL-TRADES" ADAPTABILITY

This new pump will fit many applications—water service, irrigation, slurries, circulation, transfer, factory wastes, air conditioning service, plumbing, heating, and many others. If you face conversion, this adaptability is a double value.

TEN SIZES TO FIT YOUR NEEDS

Available in ten sizes for both motor and belt drives. Capacities up to 1000 G.P.M.—with heads to 290 ft. depending upon capacity.

For complete information phone or write Pump Headquarters, Seneca Falls, N. Y. Ask for Bulletin 720.4.

MEMBER

Goulds PUMPS INC. Seneca Falls New York

QED, cont. . .

10. Know what you are going to do with the facts before you decide to collect them.

11. Consider the advantages of cooperative research in marketing.

12. Put the results to work. Of all the reasons why marketing research sometimes fails, the greatest is failure to use the results. Medicine in a bottle never cured a patient.

Vergil D. Reed, J. Walter Thompson Co., before the Society of the Plastics Industry, New York, Dec. 15, 1950.

POLYESTER LAMINATES

. . . *With Moisture Resistance*

Luther L. Yaeger

Glass fiber polyester laminates provide ease of fabrication, high strength and low weight. They are widely used but their utility has been greatly limited by the fact that the mechanical strength properties have been radically reduced on exposure to water and high humidities. Until now the best results were obtained, for example, with a complex chromium methacrylate size "114" and silicone size "113." These have still shown flexural strengths reduced by about 50 percent on immersion in water or exposure to high humidities. This has also been emphasized and recognized in the pertinent Air Force specifications.

It has now been found that such laminates can be made highly resistant to water and humidity, by applying to the glass fiber a size of vinyl chloro silane, followed by an after wash with water. It is believed that in this manner the chlorine is hydrolized off in such manner that the silicone atom in the vinyl chloro silane molecule becomes tied directly to the glass and that the vinyl grouping will react and participate in the polymerization of the resin, so that an actual bond is formed between the glass and the resin. Be this as it may, the result is that the resistance to drastic treatments with water is radically improved.

A similar relationship exists on room temperature immersion tests, a 30-day water immersion being roughly comparable to boiling 3 hr.

A still further improvement was obtained by applying beta chloro allyl alcohol in conjunction with this treatment.

This improvement applied regardless of the particular polyester employed and was verified with the principal polyesters commercially available.

The vinyl chloro silane treatment is applied either in vapor phase, or by

EMPTY BARREL OR FALSE BOTTOM?

"Only about 20 percent of the earth's surface has been searched for its resources and vast stores below the surface as well as under the sea have not been tapped to any degree."

WALLACE R. BRODE,
National Bureau of Standards

immersion in an organic solvent solution of this agent, with subsequent drying. There is nothing particularly critical in the process, which has been carried out repeatedly not only at our laboratories but also at the Forest Products Laboratory and the laboratory of the Air Force at Wright Field.

Luther L. Yaeger, Bjorksten Research Laboratories, Inc., before the Society of the Plastics Industry, Chicago, Mar. 1, 1951.

PLASTIC CURE-ALLS?

. . . *No Sir!*

C. W. *Blount*

To those who have expected plastic materials to substitute for strategic metals in civilian products, a rude awakening came in the form of a statement by the vice president of Bakelite Co.

"It has come to our attention, that currently published news reports offer promise of replacing metals with plastic materials. These reports have given the erroneous impression that plastic materials are available in quantity, have no real established uses of their own that are vital, and therefore supplies can be drawn upon immediately.

"The two most likely plastics for replacing metal in any type of construction are phenolic laminates and styrene polyester.

"Phenolic laminate materials are limited by the allocation of phenolic resin by suppliers who can not produce enough because of shortages of raw materials. The uses of these products are for such essential items as silent timing gears for automobiles, various types of electrical insulators to assure availability of electric power and numerous similar applications.

"Projected war demands for the second of these materials, styrene polyester for glass laminates, have been such that current facilities for produc-

(Continued)

CLUCK, CLUCK

"For the common defense we have thrown up a chicken-wire fence, not a wall of armed might."

SENATOR LYDON JOHNSON, *Chairman Senate "Watchdog" Committee*

If you are conveying corrosive or hard-to-handle fluids, a Saunders Patent Diaphragm Valve may be the answer to your valving problems. If so, the experience recorded in the five volumes illustrated above is your best assurance of getting the *right* valve for your needs. In these records are body and diaphragm material recommendations for handling some 2500 substances, based on Hills-McCanna's nearly 20 years' experience in the manufacture and application of Saunders Patent Valves. If you have a tough valving problem, let this "know-how" work for you.

Hills-McCanna Saunders Patent Diaphragm Valves are made in sizes from ⅜" to 14" for manual, automatic or remote operation with a choice of 13 diaphragm materials and 48 body materials. Write for complete information. HILLS-McCANNA CO., 2341 W. Nelson St., Chicago 18, Ill.

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Also manufacturers of — Proportioning Pumps
Force-Feed Lubricators • Magnesium Alloy Castings

HIGH PRESSURE TEMPERATURE PIPING

Our skill and experience can save you time and money on your next high-pressure, high-temperature piping installation. For more than half a century we have been solving the most complicated piping problems for industry, and we pioneered in methods for welding stainless. Repeat contracts with some of the nation's largest power and process plants are proof of the complete satisfaction that our service gives. The work in our plant is conducted under the most ideal conditions, and quality is rigidly controlled at every stage of processing. . . . Send us your prints for an estimate—you'll be glad you did.

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MITCHELL

TURN DUST INTO DOLLARS *with* MULTI-WASH

Central Dewatering System

Consider the salvage value of waste chemical dust. Many processors are reclaiming such dust as a valuable by-product for extra dollar volume—with Multi-Wash dust collectors.

Application of a Multi-Wash central dewatering system to your process, may very easily pay for itself and return extra profits.

Your inquiry will receive expert attention—call the local Schneible engineer or write direct.

CLAUDE B. SCHNEIBLE COMPANY
P. O. Box 502, Roosevelt Annex, Detroit 32, Michigan

SCHNEIBLE

QED, cont. . .

ing the glass fibers are being expanded several fold. Requirements of these products for landing craft, radomes, and many classified war items are such that the industry can not under any conditions hope to manufacture sufficient quantities with the materials available.

"Both of these two plastics involve resins which are made all or in part from benzene. Any expansion of availability would force a decrease in the amount of benzene for the production of synthetic rubber."

C. W. Blount, Bakelite Co.

TAXATION vs. EXPANSION

. . . *Can't Have Both*

L. S. Wescoat

The petroleum industry can provide all the oil products the country needs for decades to come if earnings required for growth are not taxed away. The trend is ominous. Taxes already are at the danger point for continuing prosperity. Even before Korea, taxes were increasing so much faster than the growth of new wealth that, if continued at the same rate, taxes will take all the earnings of the American people long before the automobile industry is a century old.

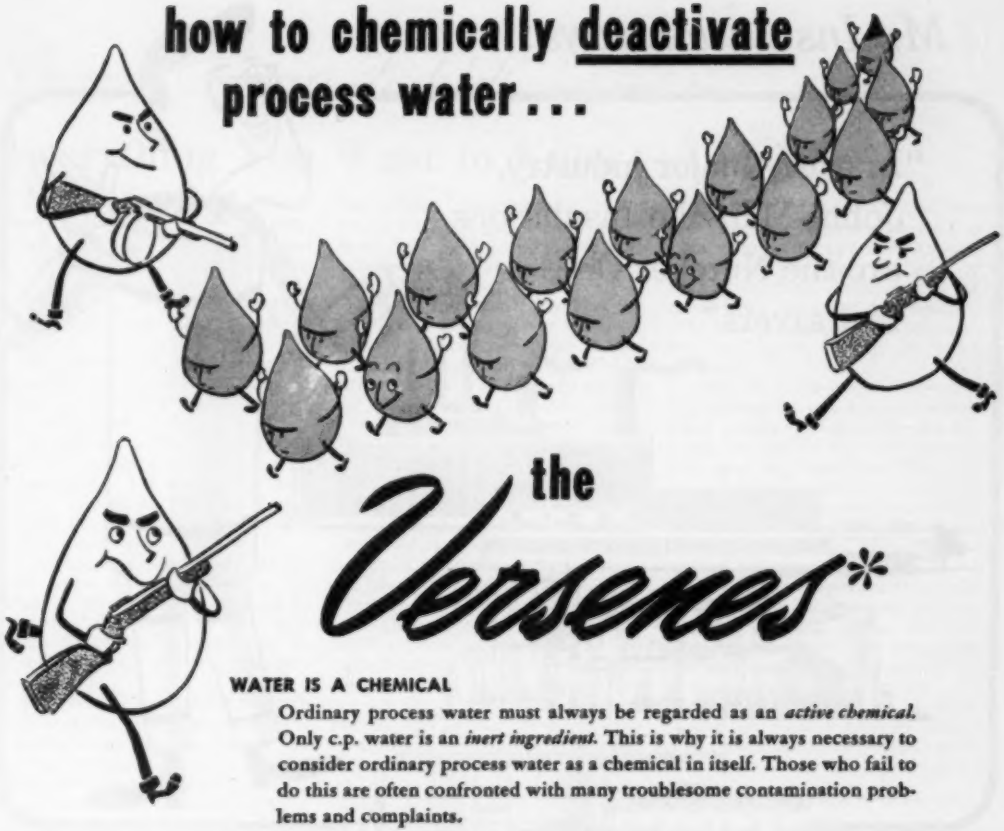
Since World War II, it has been necessary for the petroleum industry to spend $10 billion expanding and modernizing its plant. The refineries constructed in the last few years in the United States are the world's best. America is using more gasoline now than the entire world did 10 years ago. Yet gasoline rationing is not in prospect in the foreseeable future. And despite this growing demand, there is little danger of our running out of oil for decades, provided the government leaves our industry a price and tax climate in which we can breathe and grow.

The government's program for conserving tetraethyl for military use may limit the amount of fuel available for high compression engines in civilian cars. The program will prevent further increase in octane ratings of both premium and regular grades of automobile gasoline. However, unless other and greater demands are made to supply the Armed Forces, I am glad to report that the government's order will not reduce the quality of gasoline enough to noticeably impair the performance of auto engines.

L. S. Wescoat, Pure Oil Co., before automobile dealers at Chicago Auto Show, Feb. 22, 1951.

—*End*

how to chemically deactivate process water...



the Versenes*

WATER IS A CHEMICAL

Ordinary process water must always be regarded as an *active chemical.* Only c.p. water is an *inert ingredient.* This is why it is always necessary to consider ordinary process water as a chemical in itself. Those who fail to do this are often confronted with many troublesome contamination problems and complaints.

VERSENE* DEACTIVATES CONTAMINANTS

The Versenes are powerful organic chelating (complexing) agents. They are known chemically as the sodium salts of ethylene diamine tetra acetic acid and other polyamino acids. They give you exacting mathematical control over cations in solution. By keeping these troublesome metallic ion contaminants in soluble complex form, they actually deactivate them and prevent the occurrence of undesirable reactions in *any* wet chemical process.

VERSENES* ARE VERSATILE

When you suspect that your processing problem is due to contamination and may be traced to the process water used — it's time to investigate the Versenes. Perhaps you had better do it now. Write Department B. Ask for samples and Technical Bulletin No. 2.

*Trade Mark

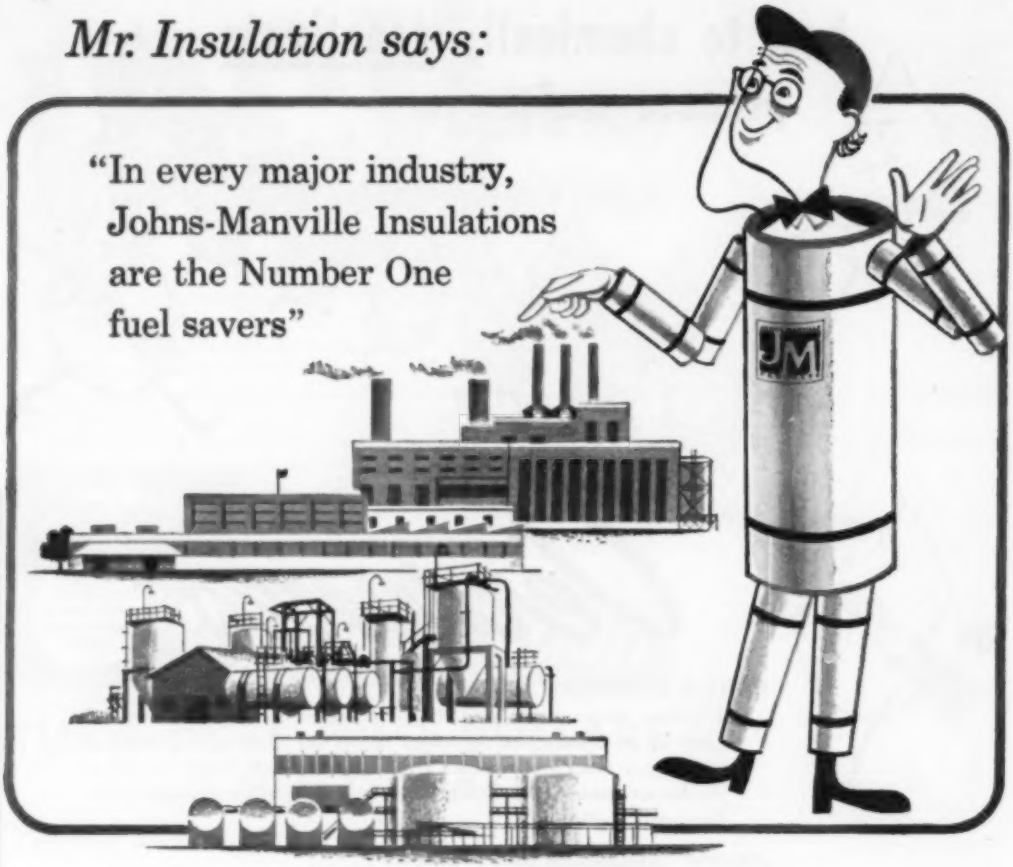
"industry's most modern chemicals"

BERSWORTH CHEMICAL COMPANY
FRAMINGHAM, MASSACHUSETTS

Warehouse Stocks

Providence Agent: George Mann, 251 Fox Point Boulevard, Providence, Rhode Island
W. Coast Agent: Griffin Chemical Co., San Francisco, Los Angeles
Midwest Agent: Kraft Chemical Co., Inc., 917 W. 18th St., Chicago
Associated Chemical Co. of Canada, 14 Darrell Ave., Toronto, Ontario

Mr. Insulation says:



IN PLANTS with stacks or stills, tanks or towers, the story is the same—"Insulation by Johns-Manville" means the maximum return on your investment. There are two good reasons for this:

1. YOU GET THE RIGHT *MATERIALS*—From asbestos and other selected raw materials, Johns-Manville manufactures a wide range of industrial insulations for service from 400F below zero to 3000F above. If you need engineering advice in determining exactly the right one for your job, you can get experienced and authoritative assistance from your local Johns-Manville insulation engineer.

2. YOU GET THE RIGHT *APPLICATION*—Even correctly selected insulation needs proper application to permit it to serve at peak efficiency through the years. Here you can always count on J-M Insulation Contractors and their highly skilled mechanics. These organizations are trained in Johns-Manville application methods, and have generations of insulation experience behind them.

Why not get the complete picture? Call on insulation headquarters when your next job is in the planning stage. Just write Johns-Manville, Box 290, New York 16, N. Y.

Johns-Manville *first in* **INSULATIONS**

Everything You Want to Know—And More

Here is a quoted sentence: "An industry may obtain (1) its entire water supply from a municipality; (2) part of its water supply from a municipality and the remainder from one or more private sources; or (3) all of its water supply from one or more private sources."

It's a pretty long sentence, isn't it? It is the first one in a new book on water treatment.* It is an example of one of the book's faults.

Suppose the author had said, "An industry may obtain its water (1) from a municipality, (2) from one or more private sources, or (3) from both." There's the same thought in less than half as many words.

Let's not imply that author Nordell used twice as many words as he needed. He just used more than he needed. And every extra word only makes it that much harder to get an idea from a page and into a reader's mind.

Eskel Nordell is one of the country's best known authorities on water. He's a prolific author on the subject. He was of invaluable assistance in the preparation of the *Chem. & Met.* Report on Water Treatment 10 years ago. He's administrator of the analytical laboratories of the Permutit Co.'s research and pilot plant divisions. During the last war he was a W.O.C. consultant on water treatment for WPB. He knows his business. He's been in it for nearly 33 years. And for five years he has been writing this book. Five years is a long time and they account in part for another fault we see in his book. There is too much of it.

It is interesting to learn the history of zeolites ("from two Greek words *zein* + *lithos* meaning 'boiling stone'") from manure pile to zero water. The author's retelling of the ancients' four-element theory of matter is amusing. So are some of his many "Notes" scattered throughout the text. (Parts of a few of these are quoted on this page.)

There is a table nearly seven pages long that lists users of water-treating equipment and types of equipment used in various industries. This is a valuable piece of compiling. But its value is not enhanced one grain by the author's reminiscences: it was started 16 years ago; there is an industry for every letter of the alphabet including Q, X, Y and Z; it was a little over five feet long.

Extra words mean extra work for the author, more pages in the book, more type to set, more work for the publisher, a higher price for the book. Extra words, as I have already pointed out, mean extra work for the reader in filtering the author's excellent ideas from a floc of verbiage.

Now, it's terrifyingly easy for an irresponsible book reviewer in a reputable magazine to damn a monumental piece of work. So let me steer you away from this book's faults. They are not going to be awfully important to the people interested in water. And there are lots of these potential customers because there is no other recent book on water treatment. Some colleges today are even using manufacturers' catalogs as textbooks. They can now switch. Laboratories, libraries and engineering consultants can now have practically the last word on water treatment. Between two covers Nordell has collected and compressed facts and figures for industries all the way from abrasive manufacturers to zinc refineries. There are 162 tables of analyses, reactions, chemicals, data for calculations, treatment requirements, conversion factors and even soap savings per family effected by water softening.

There are 18 chapters. They contain information and data from many, many sources—all distilled, filtered, mixed and treated with the author's experience and knowledge. The text logically falls into two parts: water and treatment. Seven chapters cover water supplies, requirements, impurities, analysis, sampling as well as cooling waters and boiler feeds.

The other 11 chapters on treatment go extensively into aeration and deaeration, chemical feeders, clarification, removal of iron and manganese and silica, ion-exchange processes, demineralization, distillation, hot and cold lime-soda processes. An appendix of 29 pages is full of collected tables, graphs and factors that anybody with

(*Continued*)

* WATER TREATMENT FOR INDUSTRIAL AND OTHER USES. By Eskel Nordell. Reinhold Publishing Corp., New York. 526 pages. $10.

Out of Context

Reminiscent Author

"The author recollects one case where brown stains on velvet were produced by lime and magnesia soaps." p. 185

"The author recalls a case where the introduction of oxygen-free well water . . . caused a very severe iron pickup." p. 258

"The author recollects how he [erroneously] explained that removal of sulphate and chloride ions by ion exchange was impossible." p. 404

Sarcastic Author

"Legions of illegitimate [boiler] compounds have been made of more or less equal parts of ignorance and avarice." p. 208

"The dowser, seeking a well site with his ridiculous forked divining twig, is now seldom seen." p. 33

"Just what a 'mollified electron' may be is unknown to the author but it certainly sounds harmless or even a friendly sort of creature." p. 209

"A person might be much worse occupied than in learning to drink sufficient quantities of water." p. 34

Happy Author

"The author still remembers with delight some published figures. . ." p. 190

"The author cheerfully admits that it is still not complete." p. 143

Persistent Author

"Iron or manganese 'crenothrix' may clog meters and piping." p. 2

"Iron or manganese bacteria, popularly lumped together as 'crenothrix' may become exceedingly troublesome." p. 132

". . . troublesome and clogging growths of iron or manganese bacteria ('crenothrix' is the term commonly used collectively for these)." p. 133

"Iron bacteria, popularly called 'crenothrix' frequently form clogging growths that seriously cut down flow rates." p. 318

"These [manganese] growths, like the iron 'crenothrix,' frequently break loose in large clumps and clog valves, meters, nozzles, etc." p. 333

Littleford Tanks are Designed to Fit Your Every Need

The Fabricators of Alloy Tanks require exacting, skillful workmen with the skill to shear, form and weld each tank with unerring precision.

Littleford has fabricated plain, pressure or code tanks of such metals as Stainless, Monel, Nickel, Everdur, Inconel and Aluminum for 68 years. Experience, plus modern equipment and a definite responsibility for the quality of the finished product is your assurance of the finest in fabricated tanks.

If you have a tank problem involving Alloy Metals, send your blueprints to Littleford for an estimate of cost, or write for Bulletin on Alloy Fabrication.

FABRICATORS OF PLATE AND SHEET METALS

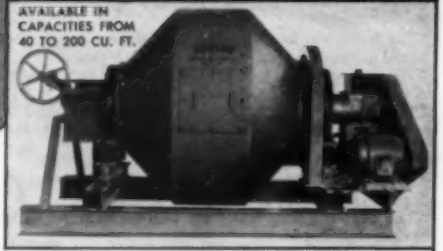
LITTLEFORD

LITTLEFORD BROS., INC.
428 E. Pearl St., Cincinnati 2, Ohio

The MUNSON Rotary BATCH MIXER

UNEQUALLED for Mixing Dry Ingredients

AVAILABLE IN CAPACITIES FROM 40 TO 200 CU. FT.



• The Munson Rotary Batch Mixer is unequalled for mixing or blending dry ingredients. It's the work-horse in many modern chemical plants where thorough blending and mixing, plus economy of operation and maintenance, are requirements of major importance.

• Design of this Mixer is flexible, to meet varied requirements. Built for either overhead, working floor or basement installation, Munson Rotary Batch Mixers range in capacity from 40 to 200 cu. ft. Total capacity depends upon desired size of batch and weight per cu. ft. of ingredients.

• In addition to general chemical applications, these Mixers are widely used in mixing fertilizers, gelatins, glue, disintegrated metals, paint ingredients, plastic compounds, soap and cleaning compounds, and a wide variety of stock feeds and tonics.

• A Munson representative will assist you in selecting the proper Mixer for your requirements. Write for full information to "Dept. M".

7-WAY ACTION
ACCURATE BLENDING
SPEEDY MIXING
RAPID INTAKE
RAPID DISCHARGE
LOW HORSEPOWER
LOW OPERATING COST

Munson Mill Machinery Co
UTICA, N.Y., U.S.A.
MACHINERY BUILDERS SINCE 1848

Also available from Munson: Rotary Knife Cutters . . . Hammer Mills (25 to 100 hp) . . . Attrition Mills (18", 24", 27", 30")

water problems will be glad to have handy in one place.

To sum up for you the results of our analysis: The quantity is in excess of normal requirements. There is a little too much hardness with a touch of turbidity. It's expensive at 52.6 ppd (pages per dollar). But the turbidity and all else will be overlooked by the many for whom the book will be as welcome as a silver zeolite exchanger on a life raft.—*LBP*

RECENT BOOKS RECEIVED

Basic Thermodynamics. By C. L. Brown. McGraw-Hilll. $4.50.
Liquid Extraction. By R. E. Treybal. McGraw-Hill. $7.50.
Medicinal Chemistry. By C. M. Suter. Wiley. $12.
Metallurgical Thermochemistry. By O. Kubaschewski & E. L. Evans. Academic. $6.
The New Physics. By Sir C. V. Raman. Philosophical. $3.75.
Principles of Chemical Thermodynamics. By M. A. Paul. McGraw-Hill. $7.50.
Thermodynamics. 2nd ed. By G. A. Hawkins. Wiley. $6.50.

Alicyclic & Acyclic

THE CHEMISTRY OF THE NON-BENZENOID HYDROCARBONS. Second edition. By Benjamin T. Brooks. Reinhold Publishing Corp., New York. 615 pages. $12.

Reviewed by R. O. Clinton

Since the first edition of Dr. Brooks' excellent treatise appeared in 1922, the field of alicyclic and acyclic chemistry has expanded tremendously. Through the efforts of petroleum chemists, and such groups as those of Egloff, Whitmore, Hurd, etc., our knowledge in this field has grown to include numerous reactions and compounds unrecognized 30 years ago.

In revising his original book, Dr. Brooks was forced to make a choice of subjects to be emphasized. For this reason the coverage of terpene and polycyclic chemistry has been drastically curtailed. Since other recently-published volumes have covered the latter fields in detail (Simonsen, Guenther), Dr. Brooks' choice appears wise.

The present volume gives complete and up-to-date coverage of such specialized subjects as thermal cracking, polymerization, alkation, oxidation, and the manufacture of synthetic organic chemicals. The usefulness of the book is increased by numerous tables of properties, and by discus-

(*Continued*)

BRIDGEPORT BRASS COMPANY
CONDENSER AND HEAT EXCHANGER TUBE EDITION

COPPER ALLOY BULLETIN

"Bridgeport" MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

Keeping Equipment In Efficient Operation

At the annual conference and exhibition of the National Association of Corrosion Engineers held at Hotel Statler, New York, March 13-16, we asked many of the visitors at our booth what problems were uppermost in their minds. Keeping equipment in efficient operation with the minimum of shutdowns is the objective of operators. Corrosion is the greatest menace to the life of equipment. Not only is the selection of the corrosion-resisting materials of paramount importance but careful control and understanding of operating conditions are most essential.

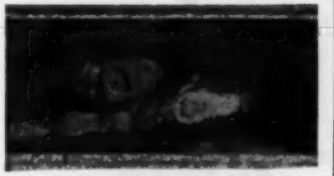
Unfortunately, there are many uncontrollable factors resulting from changes in operating conditions which affect the corrosive character of solutions and make maintenance troublesome. Changing conditions naturally affect the corrosion rate.

The need for greatly increased production often taxes the available equipment since the output is much greater than the equipment is designed to handle. The corrosion rate from the product side is greatly speeded up and the life of the equipment is proportionately reduced.

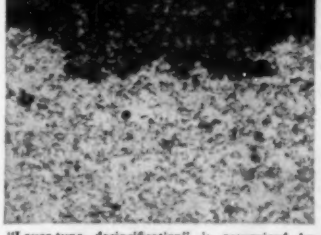
The handling of larger quantities of products generally requires greater cooling or heating capacities which are obtained by increasing the water or steam velocities. In some cases the higher velocities may tend to keep the tubes cleaner and are, therefore, beneficial. Again, exceptionally high water velocities may tend to accelerate impingement corrosion and shorten the service life of the tubes. When the impingement attack is at the inlet ends of the tubes, the use of inserts to take the brunt of the attack is recommended. Inserts are replaceable when the useful life of the old ones is destroyed.

Dezincification Can Be Reduced

Sometimes an alloy is used which is not suitable for existing conditions. Dezincification has occurred in tubes, and other parts of equipment made from uninhibited high-zinc-content brasses, especially when in contact with non-scaling types of waters. By using inhibited alloys, as for example, arsenical admiralty, arsenical aluminum brass, dezincification can be reduced or entirely eliminated. Arsenical copper and



Bottom half, longitudinal section of yellow brass pipe showing nodules of corrosion products covering areas of plug-type dezincification developed on the floor of the pipe. Note absence of nodules in top half of pipe.



"Layer-type dezincification" is recognized by relatively thick layers of deposited copper built up over a period of time. Micrograph mag. 75X.

red brass (85% copper, 15% zinc) will give much longer life in most waters than uninhibited yellow brass or uninhibited admiralty.

Trouble is experienced from paper mill liquors during the recovery cycle, primarily because of the presence of sulphides and other sulphur compounds. The steam coming from the evaporators containing much H_2S gas is well resisted by Muntz metal. 70-30 cupro nickel has given satisfactory service for handling "white liquor."

River water contaminated with sulphide wastes may also attack copper tubes. Admiralty, Muntz, and aluminum brass inhibited with arsenic are superior to copper for this condition.

Vibration Often Causes Tube Failure

Some operators are having trouble from excessive vibration of the tubing in condensers and heat exchangers. This occurs more often in re-tubed equipment where the holes in the support plates may have been enlarged, permitting a loose fit. Or the position of the support plates may have been moved, thus changing the vibration characteristics of the tubes. Periodic vibration is set in motion through the pulsating action of pumps, compressors, motors, or other equipment in proximity to the tubes. Sometimes it is helpful to change the speed of the pumps or motors to stop the tubes from vibrating excessively. Additional support plates or relocation of the support plates sometimes help.

Duplex Tubing Solves Double Corrosion Problems

To overcome the corrosive effects from gaseous hydrochloric acid either dry, wet, or mixed with other gases, Duplex Tubing with nickel to the hydrochloric acid side and a copper-base alloy to the water side is recommended. For sulphuric acid solutions, Duplex tube with lead to the acid side and copper to the steam or water side is superior to most other metals for this type of corrosion.

Steam erosion resulting from the impingement of wet, corrosive steam on condenser tubes sometimes gives trouble. Grids or deflector plates in the path of the steam will help protect the tubes. Sometimes a change in alloys is necessary. Where the corrosive agent is a trace of ammonia, 70-30 cupro nickel is superior to copper or the brasses. Where CO_2 in the steam is the corrosive agent, Duplex tubes with stainless steel outside and a copper-base alloy inside are called for. (6645)

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sions of occurrence and physiological properties, where known. Especially valuable are the well written sections on the reactions of the hydrocarbons. For example, there are excellent, though brief, discussions of the Oxo process, Reppe's syntheses in the acetylene series, and the reaction of olefins with nitrogen oxides. The literature is covered up to and including a part of 1950. Special emphasis has also been given to the more theoretical aspects of the subject, including new aspects of the strain theory and the theories of alkylation reactions.

The typography, chapter layout and indexing are excellent. The book should prove immensely useful not only to chemists immediately engaged in alicyclic and acyclic research or production, but also to organic chemists in general.

Less Than Lead or Mercury

TOXICOLOGY OF URANIUM. Edited by Albert Tannenbaum. McGraw-Hill Book Co., New York. 333 pages. $3.

Reviewed by Morris B. Jacobs

This book is Vol. 23 of the volumes comprising Division IV, The Plutonium Project Record, of the National Nuclear Energy Series and is a section of the Health volumes of this Division.

The text is divided into two parts. Part A (50 pages) is a concise summary of the work on the toxicology and pharmacology of uranium carried out by the members of the Metallurgical Laboratory and consists of eight short chapters covering such topics as the factors affecting uranium poisoning, its distribution in the tissues and excretion, gross and microscopic pathology, biochemical effects, the mechanism of action and transport of uranium to the tissues, and a summary of the experimental work. This work was performed mainly on mice but there are also data on dogs and rabbits.

Part B (276 pages) consists of 16 papers dealing *in extenso* with the topics summarized in the first part. Paper 16 (on studies of porphyrin metabolism—the effect of metals on coproporphyrin excretion) contains toxicological information on other metals, namely, lead, arsenic, thorium, beryllium, zirconium, and lanthanum. The effect of uranium on enzyme systems is considered in detail.

From the data presented, it is concluded that "uranium appears to be less of a toxicological hazard than

mercury or lead. The practice of good industrial hygiene, coupled with the not-too-toxic characteristics of uranium, should result in a decided lessening of the fear of uranium poisoning held by many when the present investigations began."

The printing, on nonglossy paper, is very clear. The illustrations are printed on the same type of paper. The book is easy to read, proof was read carefully, and it has a good binding. There were 16 collaborators, the principal ones being: Albert Tannenbaum, Herbert Silverstone, Samuel Schwartz, and E. S. Guzman Barron.

While the editor points out that the volume is not intended as a complete textbook of uranium toxicology and pharmacology, it is, nevertheless, an excellent contribution to our knowledge of uranium poisoning in particular and to pharmacology and toxicology in general.

Up-to-Date

PLANT ENGINEERING HANDBOOK. Editor-in-Chief William Staniar, 87 Contributors. McGraw-Hill Book Co., New York. 2,007 pages. $15.

The Plant Engineering Handbook contains 2,000 pages of up-to-date practices in "good housekeeping" for plant construction, maintenance and management. The editor states in his preface that the book is intended for those people in industry who are responsible for organization, design, construction, operation and maintenance. In our world of narrow specialization, this is perhaps the book's only fault. A plant manager will find the sections on costs and cost reduction, management engineering and the like, both interesting and helpful. A maintenance foreman probably will not.

Albeit, any engineer will find many chapters devoted to the latest engineering developments—developments like silicone lubricants, noise silencing, industrial glass, instrumentation and many more. These days it's not easy to keep in step with all the latest. William Staniar's handbook performs a valuable service in collecting, under one cover, comprehensive reports, each written by an expert in his field (87 experts in all), of every major industrial development of recent years. Since the intended purpose of the handbook is to supplement and extend the usual type of engineering handbook—not to replace it, we would say that the book performs a much-needed service, and performs it well.

Generously interspersed with draw-

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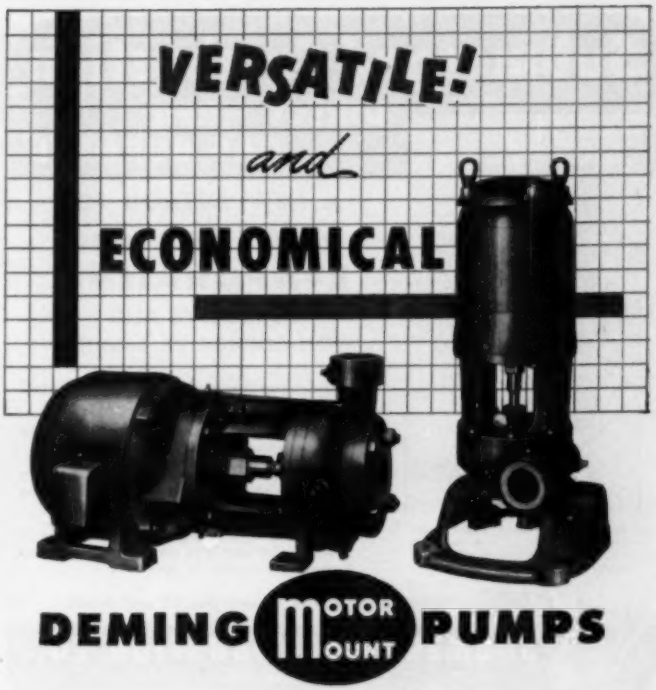

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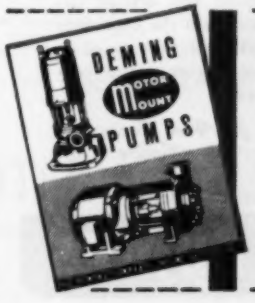

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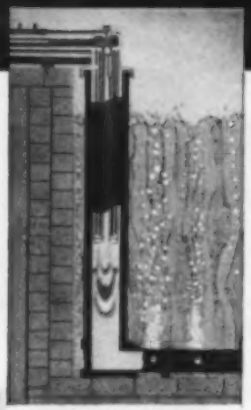

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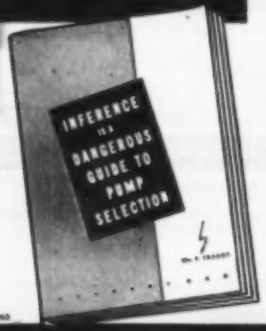

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First Place to Look

INDUSTRIAL SOLVENTS. Second edition. By Ibert Mellan. Reinhold Publishing Corp., New York. 758 pages. $12.

Reviewed by Donald F. Othmer

Chemical industry (like Gaul) may be divided into three parts: the heavy chemicals, the fine chemicals, the solvents. The total has been said to be the biggest U.S. industry—with solvents of increasing importance in our days of lacquers to be formulated, films to be cast, plastics to be processed, antibiotics to be extracted, filaments to be extruded, paints to be cleaned, and many other things to be washed, dissolved, extracted, thinned, or otherwise physically processed with solvents. The chemical uses of all of the liquids in this category are also legion.

Solvents are all things to all men and here is a book with an almost equally broad approach. Although the author says, "It is not pretended that this book is completely inclusive of all the information that could ideally be desired in this wide ranging field" he does include data for the thermodynamician, the physical and analytical chemist, the biochemist, the industrial chemist, the chemical engineer designer, the plant operator, paint and lacquer formulator, the chemical economist and administrator, and host of others—if indeed not every one in the chemical industries.

Proper attention is given to the sources of these most valuable fluids —the family relations of heritage and intermarriage, and the club or social arrangements of use and association.

The author's presentation of the dynamics and thermodynamics of the liquid and vapor states is hardly the best, the questions of formulations of solvents for synthetic and natural resin surface coatings is far from complete, the long chapter on industrial applications of solvents can at best only be spotty. And the valuable chapter (new to this edition) on safe handling of solvents cannot begin to go into all of the engineering aspects of the question. These theoretical, economic and safety considerations fill the first 234 pages; but it is the material in the next 500 pages which warrants space for this

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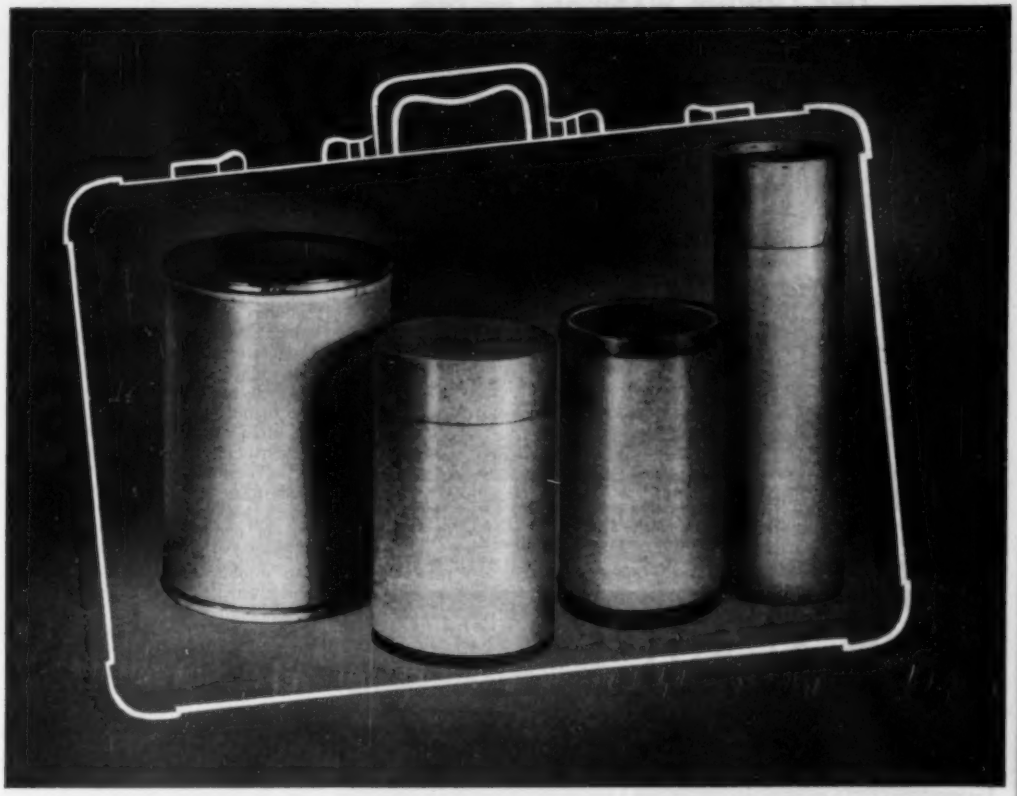

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book on the shelf of everyone concerned in any way with this subject matter. Here are data from many sources, collected and gleaned: physical, chemical, thermal, economic, use. Not uniformly presented, not always well presented, and seldom critically presented; but many data there are of a surprising range of properties. Most of the bibliography references here are to manufacturers of solvents; most of the many, many figures are lifted bodily from manufacturers' catalogues—as are also the tables. Proper this is too, to use the producers as the sources of information—since, generally speaking, the research and control laboratories of the manufacturers of these materials are often the best interpreters of the wealth of data in the literature insofar as commercial usage is concerned. And it is the solvents in commerce which has intrigued the author to put in one place so much that is known of them. Difficult it is with data so obtained to organize and present evenly, to cross index, as well as to show graphically without excessive waste space. These handicaps of compilation are evident.

Nevertheless this is an invaluable repository of the many thousands of facts about many hundreds of materials which are here made available —without writing to manufacturers, without going to *Chemical Abstracts* and its thousands of abstracted journals, without trying to find or understand the "International Critical Tables" (as of 1928 when solvents were only a trickling stream compared to their present flood). Certainly it is a first place to look for all data needed on solvents industrially.

In Partes Tres

COLLOID CHEMISTRY: THEORETICAL AND APPLIED. Vol. VII. By 45 contributors; collected and edited by Jerome Alexander. Reinhold Publishing Corp., New York. 736 pages. $15.

Reviewed by G. F. Kinney

Latest addition to Jerome Alexander's comprehensive treatment of colloid chemistry comprises 43 papers from an impressive list of contributors. The volume is in three parts, each of which may be regarded as a supplement to one of the previous volumes of the series. Part I, Theory and Methods, concerns such diverse topics as nuclear reactions, light scattering, interfacial and surface effects, ferro-

magnetism in the colloidal particle, viscosity of solutions, and chromatography. Part II, Biology and Medicine, includes articles on proteins, enzymes, drugs, gentics, antibiotic colloids, blood types, and dental caries. Part III, Technological Applications, comprises 21 articles of current topical interest, including ones on the sonic agglomeration process, the colloidal nature of soils, problems in oil-well treatment, fluid catalysts, asphalt, detergents, cosmetics, rubber reclaiming, fibers, wood, cellophane, packaging, freeze-drying, margarine, chemical warfare, and photosensitive glass.

Each of the articles included is a more or less complete paper with its own list of references. In spite of this, or perhaps because of it, the volume becomes an integral part of the whole comprehensive treatment of colloid chemistry and should join its predecessor volumes already in use. But the individual volume also has an appeal in itself, for (quoting from the jacket) "browsing through this and previous volumes provides a bird's-eye view of many outstanding developments of our time. Many readers thus discover work unknown to them which may be of great use in specific problems in their own apparently remote fields."

Incomparable

ORGANOPHOSPHORUS COMPOUNDS. By Gennady M. Kosolapoff. John Wiley & Sons, New York. 376 pages. $7.50.

Reviewed by J. S. Buck

Since this is a book written for organic chemists, inorganic and biochemical topics have not been dealt with. In fewer than 400 pages the author has compressed an immense amount of information, a considerable proportion of it from Russian sources. The reviewer is glad to see that patents have not been neglected, and he is also impressed by the singular freedom from typographical errors. The coverage seems to be virtually complete up to the end of 1949.

The author divides each chapter into three parts—methods of preparation, general characteristics and finally, a list of the compounds dealt with in the chapter. The compounds are listed by their formulas and not by names. The author has used what one might call a skeleton nomenclature, apparently to avoid the pitfalls of a nomenclature at present in a state of flux and also to attain an extreme condensation of his data. The book consequently has a somewhat unfamiliar look, as does the index, where,

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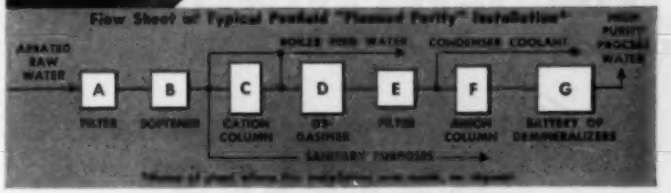

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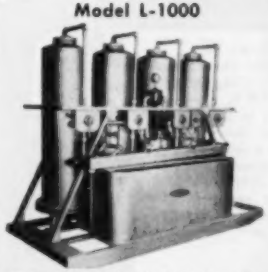

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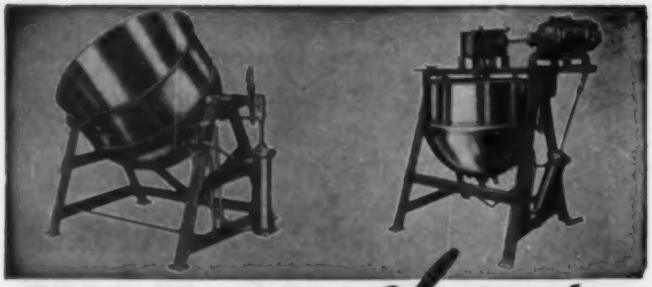

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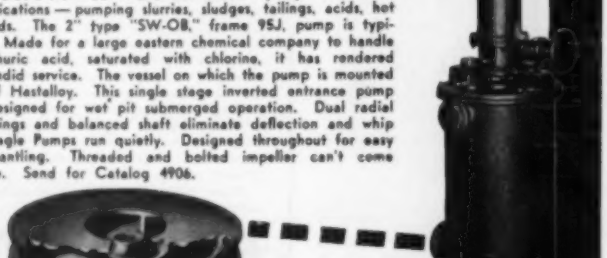

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with few exceptions, only groups of compounds, and not individual compounds, are listed. There is no author index, which is understandable considering that the bibliography gives 1804 references. However, the arrangement of compounds is such that there is no difficulty in locating an individual compound.

For any person interested in the chemistry of organophosphorus compounds, the book is indispensable as a reference work. There is nothing comparable with it in English.

Instrumentation II

PHYSICAL METHODS IN CHEMICAL ANALYSIS. Vol. II. Edited by Walter G. Berl. Academic Press, New York. 640 pages. $13.50.

Reviewed by F. C. Nachod

The high hopes of this reviewer when he reported (Chem. Eng., Aug. 1950, p. 237) on the first volume of this set have not been disappointed. The contents of the present volume as well as the contributors have been selected with care. The coverage comprises polarography (J. Heyrovsky), conductometric analysis (H. T. S. Briton), potentiometric analysis (H. A. Laitinen), electrography and electro-spot testing (H. W. Hermance and H. V. Wadlow), magnetic methods of analysis (A. R. Kaufmann), surface area (G. Jura), surface tension measurements (M. Dole), vacuum techniques analysis (B. B. Dayton), gas analysis by thermal conductivity (E. R. Weaver), tracer applications (A. Langer), statistical analysis (J. Sherman), chromatographic analysis (W. G. Berl).

Emphasis is again on instrumentation without which the rapid pace of modern analysis never could have been accomplished. Any investigator or teacher who is concerned with analytical problems can not afford to be without Dr. Berl's valuable compendium.

Common Denominator

ADVANCED ORGANIC CHEMISTRY. By Reynold C. Fuson. John Wiley & Sons, New York. 669 pages. $8.

Target for this book is the man who has already been indoctrinated with a survey of the field. Now the author hopes to drive home once and for all those fundamental theories and facts that must be part of the practicing or-

(*Continued*)

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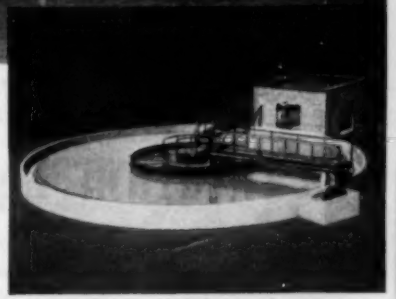

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BELOW: ACCELATOR® at Rock Island Refining Corp., Zionsville, Indiana, for treatment of waste water.

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The numerous sample syntheses are taken largely from "Organic Syntheses" to emphasize applied rather than theoretical values. Furthermore yields have been indicated in most cases—*FA*

A Trend Is Spotted

HETEROCYCLIC COMPOUNDS. Vol. II. (Polycyclic five- and six-membered compounds containing one O or S atom.) Edited by Robert C. Elderfield. John Wiley & Sons, New York. 571 pages. $15.

Reviewed by Edgar A. Steck

The rise of interest in heterocyclic types has continued for a number of years and has led to the need for a modern reference work. It is with pleasure that one notes that Elderfield has progressed toward the goal with the publication of the first two volumes within half a year. The series has been planned systematically and handled in a mature, scholarly manner with clear presentation aided by adequate formulas and references.

A study of the 14 chapters concerning the polycyclic oxygen and sulphur heterocyclic compounds will not only give much information on pure chemistry, but also a number of uses. Some of the substances discussed are of value as analytical reagents, dyestuffs, pharmaceuticals, insecticides, and others are responsible for the beauty of many flowers. While most of the work is complete up to 1948, the only significant omission appears to be lack of mention of Miracil D, an effective anti-bilharzial agent, in the chapter including thioxanthones. The related xanthone types were included, however. The editor has again contributed directly to the work, and has been ably supported by the contributors, who are: D. K. Fukushima, V. B. Meyer, W. E. Parham, D. S. Tarbell, and S. Wawzonek.

It may be of interest to observe that the present series of truly valuable reference books has been subject to price increases. The first volume, which cost $11 last summer, is now $15. Trends of such extent may well affect sales, even when the ready ac-

cessibility of much information may be at stake.

Tailor-Made

TEXTBOOK OF ORGANIC CHEMISTRY. By Louis F. Fieser and Mary Fieser. D. C. Heath and Co., Boston. 749 pages. $6.

Out of the whole cloth of the second edition of the authors' "Organic Chemistry" (See *Chem. Eng.*, Jan. 1951, p. 269) this text has been tailor-made for an introductory one year course. The material has been reworked and, here and there, cut down to suit initiation rather than reference and refresher purposes.

Presentation of fundamental principles and theory remains substantially intact. However, scope of chapters on technological subjects has been narrowed. Certain of these shortened chapters (for instance, one on biochemistry) may be omitted from a beginners' course without loss of continuity. Sections on proteins, carbohydrates and fats have been reslanted.

Each chapter ends with a summary of the facts and principles covered and problems testing their application. Answers to problems are furnished at the end of the book.—*FA*

A Service

PRINCIPLES OF IONIC ORGANIC REACTIONS. By Elliot R. Alexander. John Wiley & Sons, New York. 318 pages. $5.50.

Reviewed by S. Archer

The author devotes the first third of this book to general principles, covering such topics as resonance, hyperconjugation, carbonium ions, carbanions, displacement, elimination and addition reactions. The remainder of the book is concerned with the application of previously discussed principles to specific reactions. A large number of these are covered in relatively small space.

The concept of resonance is introduced by definition and is developed by means of specially illustrated generalizations. Illustrations are drawn exclusively from the field of organic chemistry. Several examples are really instances wherein the concept of resonance is used to explain the behavior of certain molecules, e. g. strict inhibition of resonance, benzene substitution, etc. The contributions of Pauling and Ingold are not mentioned.

It is strange that the author failed to mention the work of Baker and

(*Continued*)

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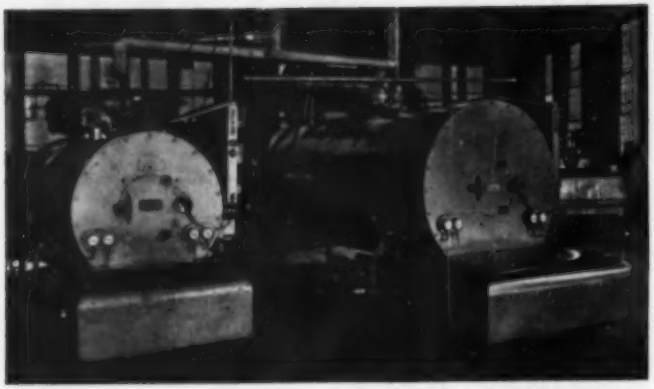

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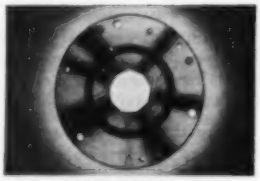

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Nathan in his discussion of hyperconjugation. This phenomenon had been known as the Baker-Nathan effect before the term hyperconjugation had been coined. It is stated that hyperconjugation "involves hydrogen atoms alpha to a double bond of an electronically deficient atom" This idea is invoked to explain why hydrogen bromide adds to propylene to give isopropyl bromide rather than normal propyl bromide. It is difficult to see how this concept can be applied to the behavior of trichloromethylethylene, which as Kharasch has shown, adds hydrogen chloride normally.

In the discussion of carbonium ions, both classes, those which do exist in solution and those which are transitory reaction intermediates are considered together. It is sometimes difficult to distinguish between the two groups.

It is stated that "the carbonium ion must be able to pass through a planar configuration." The lack of reactivity of 1-chloro-apocamphane toward alcoholic silver nitrate and the nonconductivity of 1-bromotriptycene in liquid sulphur dioxide is offered as support of this contention. Later the author explains the lack of reactivity of these two compounds by stating that "carbonium ions cannot be formed because a planar intermediate is prohibited."

A cyclic brominium ion is the reactive intermediate in such similar reactions as the addition of bromine to double bonds (p. 146) and the reaction of bromohydrins (p. 100). The pinacol reaction may be formulated in a similar way. This would be better than giving a carbonium ion mechanism and then stating later that the reaction does not proceed in discrete steps.

The hydrolysis of alpha, gamma-dimethyl-allyl phthalate (p. 233) can best be explained by assuming that in dilute alkali an anion tropic rearrangement occurs and that in stronger alkali the SN_i mechanism supervenes. Such an explanation was used later by the author to account for the behavior of crotyl chlorides. The author claims that it is unlikely that carbonium ions can be formed in alkaline solution but this is only true if the ion is found by the addition of a proton to a double bond rather than by a preliminary dissociation of the molecule.

The author has done a service in not trying to "sell" the electronic theory of organic reactions. He is frank in admitting that certain points are not clear. Despite its shortcomings,

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A	90-65-02	95/105000	70/75000	2.5/5.5	225/265	As-cast
B	80-60-05	85/95000	65/70000	5.5/10.0	195/225	As-cast
C	60-45-15	65/75000	50/60000	17.0/23.0	140/180	Annealed
D	80-60-00	85/95000	65/75000	1.0/3.0	230/290	As-cast

A Pearlitic in structure. Provides good mechanical wear resistance.

B Pearlitic-ferritic in structure. Provides strength and toughness combined.

C A fully ferritic structure usually obtained by short anneal of either (A) or (B). Provides optimum machinability and maximum toughness.

D Higher phosphorous content than preceding grades, also higher manganese. Provides high strength and stiffness, but only moderate impact strength.

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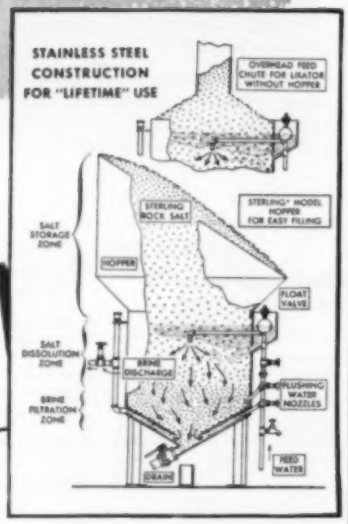

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AEC Business. "U. S. Atomic Energy Commission Contracting and Purchasing Offices and Types of Commodities Purchased." How to do business with the AEC: what is bought, who buys it, where are the procurement offices located. Instruction on how a business firm may qualify to receive invitations to bid. Up to date as of March 1951. 15 cents. Superintendent of Documents, Washington 25, D. C.

Ethylene Oxide. Properties and essential information for safe handling and use. 20 cents. 18 pages. Chemical Safety Data Sheet SD-28, Manufacturing Chemists' Assn., 246 Woodward Bldg., Washington 5, D. C.

Hazardous Chemicals. "Hydrochloric Acid, Aqueous and Hydrogen Chloride, Anhydrous." Properties and essential information for safe handling and use. 28 pages. 35 cents. Chemical Safety Data Sheet SD-29, Manufacturing Chemists' Assn., 246 Woodward Bldg., Washington 5, D. C.

Glass. "Glass—Its Place in Chemical Processing." Tells the engineer why, where, and how this versatile material can find applications in his plant. Covers not only glass in bulk form, but also as linings and fibers. By Julian C. Smith. Reprinted from April 1951, *Chemical Engineering*. 13 pages. 75 cents. *Chemical Engineering*, Editorial Dept., 330 West 42nd St., New York 18, N. Y.

Piping. "Code for Pressure Piping." Power, gas and air, oil, district heating, refrigeration, fabrication details, materials and appendix. 102 pages. $4.50. ASA B31.1-1951. Publication Sales Dept., American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.

Quality Control. "ASTM Manual on Quality Control of Materials." Organized in three parts. Part 1 essentially covers the presentation of data; part 2 present limits of uncertainty of an observed average; part 3 explains the control chart method of analysis and methods for presentation of data. A table is given to permit ready calculation of 99 percent, 95 percent and 90 percent "confidence limits" for various sample sizes. 100 pages. $1.75. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

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Lime. "Chemical Lime Facts." Two section: one discusses uses in metallurgy, pulp and paper, chemicals, water treatment, sewage-trade waste treatment, ceramic products, building materials, protective coatings, food and food byproducts; the other discusses principal chemical and physical properties including such properties as solubility, pH, strength of lime suspensions, specific vents, crystalline structure data and neutralization values. 42 pages. Gratis. National Lime Assn., 925-15th St., N. W., Washington 5, D. C.

Hydrocarbon. "Physical Constants of Hydrocarbons Boiling Below 350 deg. F."

Six classes of hydrocarbons are covered including paraffins, mono-olefins, di-olefins, acetylenes and naphthenes, and aromatics. 16 pages. $1. STP No. 109, American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Petroleum. "ASTM Manual on Measurement and Sampling of Petroleum and Petroleum Products." Gaging, temperature measurement, volume calculations and corrections, water and sediment, gravity, sampling. Photographs and figures show latest types of apparatus. 132 pages. $2. American Society for Testing Materials, 1916 Race St., Philadelphia 2, Pa.

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Fibers. "Trends in the Consumption of Fibers in the United States 1892-1948." Significant data on numerous types of synthetic fibers as well as on cotton, wool and silk. By Barkley Meadows. 35 cents. Dept. of Agriculture Statistical Bulletin 89, Superintendent of Documents, Washington 25, D. C.

Titanium. "Bibliography on Titanium." List of significant publications of government and industry including both minerals and industrial utilization. By Jean R. Carpenter and Gwendolyn W. Luttrell. U. S. Geological Survey Circular 87, Superintendent of Documents, Washington 25, D. C.

Heater. "Performance of a Pebble Heater Type Steam Superheater." Report of experimental studies on apparatus for the gasification of powdered coal with oxygen and superheated steam. By H. R. Batchelder and H. A. Ingols. Bureau of Mines RI 4781, Superintendent of Documents, Washington 25, D. C.

Dust Control. "Investigation of a Photoelectric Device for the Determination of Low Concentrations of Dust." Research report on apparatus for air pollution investigation. By D. E. Stone et al. Bureau of Mines RI 4782, Superintendent of Documents, Washington 25, D. C.

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Norman S. Mott
Chief Chemist and Metallurgist

In the normal specification range for the 18-8 chromium-nickel stainless steels, especially when the carbon is low, ferrite and the resultant magnetism will often be found. It must not be construed, however, that this condition is detrimental to the properties of stainless steel; in fact, in many cases it is highly desirable.

The fully austenitic stainless steels, when heated in the carbide precipitation range (900–1600°F.) have their carbon precipitated as chromium carbide along the grain boundaries. This depletes the boundaries of chromium with the result that the alloy becomes susceptible to intergranular corrosion.

When alloys containing amounts of ferrite from 3–15% are heated in this temperature range, it is found that the carbides tend to form predominantly in the ferrite areas. Since these areas are disconnected and well distributed, the condition does not promote intergranular corrosion.

Stainless steels with free ferrite up to 30% in amount retain good mechanical properties, although they show a slight decrease in ductility and toughness. Their strength and hardness are increased.

Estimation of the presence and approximate amount of ferrite may be accomplished by the use of a phase diagram based upon nickel and chromium equivalent values.* The nickel and chromium equivalent values are computed by the equations:

$$Ni^e = Ni\% + 0.5\,Mn\% + 30\,C\%$$

$$Cr^e = Cr\% + Mo\% + 1.5\,Si\% + 0.5\,Cb\%$$

The boundary line between fully austenitic alloys and those which contain ferrite is expressed by the equation:

$$Ni^e = \frac{(Cr^e - 16)^2}{12} + 12$$

When a higher percentage of nickel is specified in type 316 moly bearing alloys in order to make them completely austenitic in structure, they become susceptible to intergranular corrosion, and if they are to be heated in the carbide precipitation range, as would occur during welding, additions of columbium are required to counteract this susceptibility.

Molybdenum additions to 18-8 stainless make the alloy magnetic due to the formation of ferrite, and existing data have shown that the presence of this ferrite does not interfere with the high corrosion resistance of the alloy. In this form, it enjoys a wide range of usage where excellent resistance to corrosive media and the effects of welding heat are required.

*A. L. Schaeffler, Metal Progress, November, 1949, p. 680-B.

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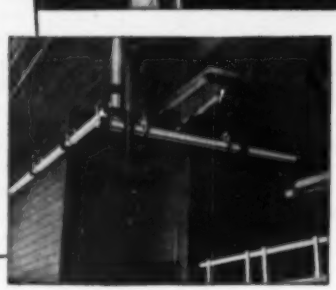

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Water. "First Annual Report, Ohio River Valley Water Sanitation Commission, 1948-49." 34 pages. Ohio River Valley Water Sanitation Commission, 414 Walnut St., Cincinnati, Ohio.

Computers. What automatic computing devices mean to chemistry, the process industries and the chemical engineer. True potentialities of a new science. Reprinted from December 1950, *Chemical Engineering*. 14 pages. 75 cents. *Chemical Engineering*, Editorial Dept., 330 West 42nd St., New York 18, N. Y.

Safety. "American Standard Safety Code for Ventilation and Operation of Open-Surface Tanks." Rules on personal protection, operation and inspection, maintenance and installation; special precautions for cyanide and vapor degreasing tanks. 24 pages. 75 cents. American Standards Assn., 70 East 45th St., New York 17, N. Y.

Aluminum. "Aluminum—The Industry and the Four North American Producers." Sets forth the industry's progress, processes, products, markets, economics, outlook, selected statistics, and the highlights of four North American producers: Aluminum Ltd., Aluminum Co. of America, Kaiser Aluminum & Chemical Corp., and Reynolds Metals Co. Liberally sprinkled with charts, maps, photographs, tabular material. 80 pages. First Boston Corp., 75 Federal St., Boston 6, Mass.

Ethane. "Effect of High Pressures on the Explosibility of Mixtures of Ethane, Air, and Carbon Dioxide and of Ethane, Air and Nitrogen." By R. E. Kennedy. Bureau of Mines, RI 4751, Superintendent of Documents, Washington 25, D. C.

Coal. "Pilot-Plant Gasification of Pulverized Coal with Oxygen and Highly Superheated Steam." By G. R. Strimbeck. Bureau of Mines, RI 4732, Superintendent of Documents, Washington 25, D. C.

Civil Defense. "Health Services and Special Weapons Defense." Fully describes a program for the development of State and local civil-defense health services. 280 pages. 60 cents. Federal Civil Defense Administration AG-11-1, Superintendent of Documents, Washington 25, D. C.

Safety. Proceedings of a conference in Britain on chemical works safety. Seven papers covering principally fires and pressure vessels. 183 pages. 5 s. Association of British Chemical Manufacturers, 166, Piccadilly, London, W.1, England.

Ammonium Nitrate. Methods for handling, storage and use of fertilizer-grade ammonium nitrate. 24 pages. 50 cents. Manufacturing Chemists' Association, 330 West 42nd St., New York 18, N. Y.

Byproducts from Milk. Physical and chemical characteristics of milk, skim milk, whey and buttermilk and their components. Methods for converting them to profitable commercial uses. By Earle O. Whittier and Byron H. Webb. 517 pages. $6. Reinhold Publishing Corp., 330 West 42nd St., New York 18, N. Y.

Taxes. "Tax Aspects of Patents, Copyrights and Trade-Marks." Defines the nature of these rights. How fundamental principles of taxation apply to them. By Paul Gitlin and W. R. Woodward. 80 pages. $2. Practising Law Institute, 57 William St., New York 5, N. Y.

Electrochemistry. "Transactions of the Electrochemical Society." 405 pages. $7. Vol. 96, Electrochemical Society, 235 West 102nd St., New York 25, N. Y.

—End

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Note how a bath of 20 percent solution of sulphuric acid eats away the steel gear at left, while the Enrup gear is unharmed. Enrup is non-conductive, non-absorbent, easy to clean, is noiseless.

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NEW TECHNICAL LITERATURE

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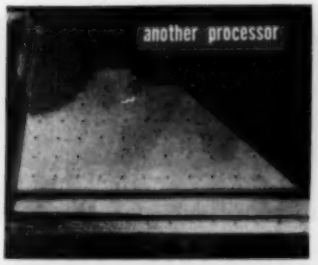
SUBJECT	FEATURES	COMPANY
Water Conditioning 310A	Self-contained high-rate unit for the removal of hardness, turbidity, color and algae from municipal and industrial water supplies. Contains large cross-sectional and cutaway drawings of each of four models. Discusses operation and fields of application. Installation photos; tables of typical operating results. 24 pages.	Dorr Co.
Rubber 310B	Handbook (20 pages), wall charts and monthly bulletins containing hundreds of illustrations and suggestions on how to select, install and maintain conveyor belting, flat transmission belting, hose, V-belts and packing. Called the "Conservation Maintenance Plan," it's intended to help the nation's industrial plants conserve vital rubber.	Quaker Rubber Corp.
Chemicals 310C	Two data sheets: one on ethylene chlorobromide, a solvent, intermediate and fumigant; another on dichloroacetaldehyde, a new intermediate. Typical reactions, properties, analysis and availability.	Westvaco Chemical Division
Air Conditioning 310D	Direct expansion units: centrifugal header type for units having tube lengths longer than 2½ ft.; weir header type on the shorter tube length coils. Selection examples; piping diagrams. Performance tables, 10 pages of them. Physical and dimensional data. 48 pages.	Aerofin Corp.
Conveyors 310E	Steel belt conveyors. Photographs and sketches show various types and their operation in different applications. Step-by-step description of a conveyor's construction, accompanied by drawings. Diagrams give a general view of a conveyor and its different parts as well as various designs with reference to the principal layout. Hard covered book. 48 pages.	Sandvik Steel Inc.
Valves 310F	Safety valve without springs and with a clapper type solenoid. Large cross-sectional view, installation data. 4 pages.	Ross Operating Valve
Pumps 310G	Horizontal, end-suction centrifugal type. One is a close-coupled electric motor driven pump (Peerless Type PE). The other is a bracket-mounted pump for driving through a flexible coupling, or V-belt, or flat-belt pulley (Peerless Type PB). For various models: sketches showing parts; dimensional diagrams and charts. Selection charts. 24 pages.	Peerless Pump Division
Instruments 310H	For continuous viscosity measurement and control of industrial processes. Operational drawing and photograph accompany discussion of each member of the line. 12 pages.	Fischer & Porter Co.
Valves 310I	Forged steel, union bonnet needle valves for high pressures and corrosive services. 4 pages.	Kerotest Mfg. Co.
Blower 310J	Dimensional information: engineering layout; typical application data; important design data; blower number; cfm. at listed rpm. 6 pages.	Standard Stoker Co.
Stainless Tubing 310K	Analyses, oxidation resistance, thermal treatment and mechanical, electrical and physical properties on 10 of the most popular austenitic and ferritic stainless tubing steels. 4 pages.	Babcock & Wilcox Tube Co.
Equipment 310L	Condensed catalog showing representative items in a line of heat transfer equipment, blenders and process vessels such as kettles, mixers, autoclaves. 4 pages.	Patterson-Kelley Co.
Dust Suppressor 310M	For dust, fumes and smoke. When used on foundry cupolas, it removes all gases and suppresses over 95 percent of the solids. Operating principle; installation photographs. 4 pages.	Whiting Corp.
Corrosion Resistance 310N	Pumps and heat exchangers designed for transfer of corrosive liquids, hot or cold. Photographs and brief descriptions. 4 pages.	Nukem Products Corp.
Safety 310P	Automatic artificial respiration—intermittent positive pressure without suction. Use of the portable apparatus is pictured and described. 4 pages.	Mine Safety Appliances Co.
Conveyors 310Q	Revision of a previous bulletin on 11 standardized conveyor units. Photographs show construction and installation; specifications. 24 pages.	Standard Conveyor Co.
Cement 310R	Photographs show procedure for applying corrosion-resistant cement over steel gridwork. 1 page.	Pennsylvania Salt Mfg. Co.
Condenser Tubes 310S	Combating corrosion of condenser tubes; choice of condenser tube materials. This company's methods for tracking down the sources of problems and its solutions to them. 28 pages.	Revere Copper and Brass Inc.
Peracetic Acid 310T	A new bactericide-fungicide. Details on uses and applications in the food industry. Mimeographed. 21 pages.	Buffalo Electro-Chemical Co.
Materials Handling 310U	Gas and electric fork lift trucks, motorized hand trucks, hand lift trucks, and hand and electric hoists, various attachments available. General descriptions, application data, photographs. 44 pages.	Yale & Towne Mfg. Co.
Chemicals 310V	A technical grade of sodium trichlorophenate to control the formation of slime in industrial cooling waters. Available in experimental quantities. Chemical and physical properties; test data; information for its use. 8 pages.	Monsanto Chemical Co.

SUBJECT	FEATURES	COMPANY
Bellows 311A	Design considerations, specifications charts, photographs and construction drawings of a line of bellows suited for applications of control devices and instrumentation. Available in a range of sizes and metals such as brass, stainless, bronze, Monel and Inconel in single and multi-ply construction and in various lengths. 16 pages.	Chicago Metal Hose Corp.
Materials Handling 311B	Trucks which can handle a wide variety of heavy and bulky products by straddling or rolling over the load to be transported. Photographs show the types of jobs it does and close-up views show just how it works. Dimensional drawings and charts giving load capacities and weights. 16 pages.	Hyster Co.
Water Softeners 311C	Zeolite softeners featuring a single control valve. Data for laying out a zeolite water softening plant, factors governing the sizing of such equipment, selection of zeolite material, four steps of operation of a zeolite softener. Diagrams and equipment and installation photographs.	Cochrane Corp.
Conveyor Chains 311D	Types of chains and which conveying jobs they handle best; proper attachment for each type. Various constructions and applications are illustrated. 12 pages. Another bulletin discusses a new chain of the flat-top type which can flex in two planes and can curve around corners. 4 pages.	Chain Belt Co.
Power Units 311E	Detailed specifications and performance characteristics of two units designed for stud welding. One gives stud welding performance equivalent to two conventional 400-amp. generators in parallel. The other is a battery unit with a self-contained automatic charging device. 4 pages.	Nelson Stud Welding Division
Flanges and Couplings 311F	Flange and coupling selector in slide rule form. Flange size selector lists O.D. of flange, thickness, O.D. of raised face, number and diameter of holes, diameter of bolts, bolt circle. Coupling selector shows average sizes of standard, extra heavy, 3,000 and 6,000 lb couplings.	Nooter Corp.
Cast Monel 311G	Physical and mechanical properties; machinability and weldability characteristics. Charts show corrosion resistance to various materials. 8 pages.	Cooper Alloy Foundry Co.
Demineralizer 311H	Permanent cartridge demineralizer. Operation details and sketch. Uses. Pocket-sized leaflet. 6 pages.	Penfield Mfg. Co.
Tubing 311I	Carbon, intermediate chrome molybdenum and stainless steels used in high temperature, high pressure service. Chart gives analyses, physical and mechanical properties, creep strength, short time elevated temperature tensile strength and oxidation resistance of 14 tubing steels. 6 pages.	Babcock & Wilcox Tube Co.
Dust Precipitators 311J	Designed to handle fly ash, cinders and industrial dusts, this company's Series 342. Photographs, diagrams and cutaway views show operation and assembly arrangements. Chart gives dimensions and physical data. 12 pages.	American Blower Corp.
Water Softening 311K	Hydrogen zeolite cation exchange process, field of application. Also covers the zeolites themselves and the details of the equipment used in the process. 16 pages.	Cochrane Corp.
Instruments 311L	Self-contained indicating deflection type instrument for measurement and automatic control of temperatures on any type of heating equipment. Several cutaway views with clearly shown and labeled parts. 2 pages.	Wheelco Instruments Co.
Consultant 311M	Facilities, activities, personnel and history of this consulting firm. Written in humorous, chatty style; cartoon illustrations. 28 pages.	Foster D. Snell, Inc.
Atomic Energy 311N	Facilities of this company particularly research, development and design engineering for the atomic energy field. Outines the work it has done for AEC and the Armed Services since it was founded in 1943. 18 pages.	Kellex Corp.
Pump 311P	Designed to force liquids or gases through tubing, its operation is not affected by solids in the solution. Liquid being pumped does not come in direct contact with pump parts. For laboratory and pilot plant. 4 pages.	E and M Enterprises
Chemicals 311Q	Dibasic acid obtained by dimerization of linoleic acid now available in commercial quantities. Specifications and characteristics, shipping and handling, general aplications such as surface coatings, soaps, greases, insecticides. Known as Emery 955 Dimer Acid. 16 pages.	Emery Industries
Safety 311R	"The Hazards of Synthetic Plastics." The where and why in manufacture and use. 4 pages.	Assn. of Casualty & Surety Cos.
Gas Conditioner 311S	A device with no moving parts for continuous removal of petroleum vapor, dirt and liquids from compressed air and other gases. Cutaway drawings enlarge on a discussion of how the device works. 4 pages.	Selas Corp. of America
Motor Control 311T	Polarized field frequency controls (standard interrupting capacity type) for synchronous motors. Ratings, weights, dimension drawings, wiring diagrams, layout drawings and specifications for each type of control. 8 pages.	Electric Machinery Mfg. Co.
Protective Coating 311U	For protection of aluminum, a coating known as Alodine. Forms an amorphous, non-crystalline phosphate surface. Properties, application directions. 4 pages.	American Chemical Paint Co.
Expansion Joints 311V	Phantom drawings and photographs show how the joints are put together. Charts give prices, weights, dimensions. Photographs of typical installations. 16 pages.	Yarnall-Waring Co.
Diesel Engines 311W	Four-cycle, direct injection, totally enclosed engines. Photographs, cutaway drawings, specifications. 18 pages.	Worthington Pump and Machinery Corp.
Paint 311X	Suggested formulations utilizing GE's new fast-drying Glyptal alkyd resin 2522.	General Electric Co.

(*Continued*)



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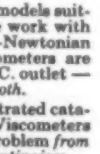

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NEW TECHNICAL LITERATURE, *cont. . .*

SUBJECT	FEATURES	COMPANY
Chemicals 312A	Typical reactions of dihyroxy diphenyl sulfone. Information on two forms of mixed isomers available in commercial quantities and two purified isomers which can be supplied in experimental amounts. Suggested uses for the sulfone or its reaction products include an electroplating bath additive, a stabilizer for cellulose materials, adhesive formulations. 8 pages.	Monsanto Chemical Co.
Materials Handling 312B	Hand trucks, platform trucks, barrel trucks, skids, dollies and a complete line of rubber-tired and semi-steel wheels. Lists specifications and selection recommendations.	Modern Equipment Co.
Work Gloves 312C	anvas and cotton knit gloves processed with natural rubber. Applications, range of styles, sizes and colors available. 4 pages.	American Rubberizing Co.
Corrosion Resistance 312D	Pocket-sized, slide-rule device which tells the proper non-ferrous or stainless steel alloys to use for 142 corrosive situations.	H. M. Harper Co.
Fork Trucks 312E	This company's model FT-60, of 6,000-lb. capacity. Specifications; photographs showing use of the truck in various industries and applications. 8 pages.	Baker-Raulang Co.
Coupling 312F	Photographs and dimensions of each types of couplings as straight-through, one-way shut-off or two-way shut-off, or special service couplings for oxygen, acetylene, gasoline, steam or other applications. Catalog is composed of various loose-leaf bulletins.	Hansen Mfg. Co.
Oil Burners 312G	Long nose type low pressure air atomizing oil burners which burn any grade of fuel oil. Specifications, sizes and dimensions. 2 pages.	Hauck Mfg. Co.
Instruments 312H	Shows graphic performance and gives specifications for 10 new type resistance wire strain gages (this company's SR-4 line). 2 pages.	Baldwin-Lima-Hamilton Corp.
Flooring 312I	A floor surfacing for resisting excessive water conditions, oils, greases and acids. Photographs show how to apply and use. 4 pages.	Stonhard Co.
Valves 312J	Materials of construction, prices, sizes on a line of valves including: bronze valves and cocks, iron valves and cocks, iron and brass unions, expansion and swing joints. 8 pages.	H. K. Porter Co.
Air Pollution 312K	Electronic air cleaners for use in factories, stores, offices and homes. How they operate; where they can best be used; how they're constructed; kind of unit to select for a given job. 8 pages.	Westinghouse Electric Corp.
Fire Brick 312L	Cross-section drawings show typical applications of plastic refractory in hand-fired, stoker-fired and oil-fired furnaces. 4 pages.	Ironton Fire Brick Co.
Equipment 312M	Two bulletins. One covers fertilizer machinery. Blueprints show single and double mixing units. Photographs show construction and parts of dry batch mixers, screen, hammer mill pulverizer, custom-built steel elevators. 16 pages. Another bulletin covers vibrating screens. 4 pages.	Sturtevant Mill Co.
Instruments 312N	Portable, direct reading, metal hardness tester. How to use. Photographs. 4 pages.	Newage International, Inc.
Aluminum 312P	Steel with a special coating of aluminum. Describes heat and corrosion resistance and heat reflectivity. Lists mechanical and forming properties, available sizes and gages, detailed recommendations for welding by various methods, brazing and finishing. Photographs and a listing of applications show where manufacturers have used the aluminum-coated steel in a variety of products. 24 pages.	Armco Steel Corp.
Flooring 312Q	Resurfacing and patching material for concrete floors. Discusses its ability to withstand loads and to resist acids, oil and moisture. Recommends fields of application. 4 pages.	Monroe Co.
Hydraulic Fluids 312R	Fire-resistant fluids. Discusses high viscosity index, low leakage loss. Recommends use in die-casting machines, mechanical manipulators, strap balers, electric welders. 12 pages.	Carbide and Carbon Chemicals Division
Chemicals 312S	Properties, uses and prices of three reagents: dipotassium rhodizonate, disodium rhodizonate and tetrahydroxyquinone.	Jasonols Chemical Corp.
Equipment 312T	Rotary soot blower head—automatic, power driven. Cutaway drawing and photograph show design features. 4 pages.	Vulcan Soot Blower Division
Process Vessels 312U	Facilities of this company in the fabrication of tanks and vessels for the petroleum and chemical processing industries. Steel and alloy plate fabrication. Corrosion data charts list resistance values of commonly used metals with reference to hundreds of chemicals. 16 pages.	Nooter Corp.
Water Conditioning 312V	Ion exchange systems to provide water practically free from hardness, carbon dioxide and silica. Block diagrams illustrate case histories of results attained in deionization by typical monobed, two-, three-, and four-bed systems. 4 pages.	Rohm & Haas Co.
Water Treatment 312W	Use of organics in altering the nature of sludge in order to make it non-adherent. Theoretical and practical considerations. 4 pages.	E. F. Drew & Co.
Load Cells 312X	Illustrates and gives specifications for a new line of seven Type U-1 SR-4 universal load cells ranging in weighing capacity from 500 to 50,000 lb. in tension and compression. 2 pages.	Baldwin-Lima-Hamilton Corp.

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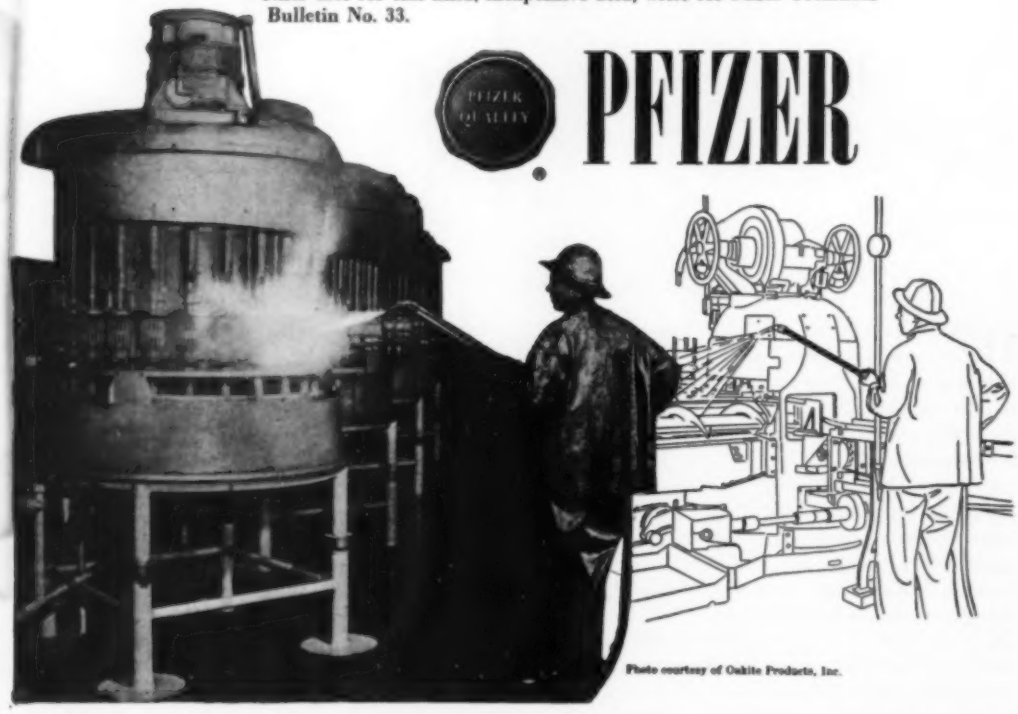

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The 10 Biggest Consumers of Chemicals

The Big Ten at War's End	Today's Big Ten	INCREASE SINCE 1945
Fertilizers	Fertilizers	40%
Glass	Paint, varnish & lacquer	77%
Pulp and paper	Pulp and paper	54%
Petroleum	Rayon	53%
Rayon	Petroleum	36%
Paint, varnish & lacquer	Glass	23%
Iron and steel	Plastics	204%
Textiles	Iron and steel	37%
Coal products	Textiles	33%
Plastics	Coal products	18%

How the CPI Is Expanding

Value of output in the chemical process industries is fast approaching the $50 billion mark. According to preliminary estimates the value of output for the CPI will pass the $47 billion mark this year. This growth is not unexpected. Reason: tremendous amounts are being spent each year to increase the physical capacity of the fastest growing segment of U. S. industry.

In 1951 the CPI will spend $5.4 billion in capital expenditures. This is $1.1 billion ahead of last year's rate. Most of this money will go into the construction of additional plant capacity.

Since the last war this plow-back of earnings has been used to build up our chemical processing capacities until they now can produce about 70 percent above their 1946 levels. This growing capacity is reflected in the consumption of chemicals in all parts of the CPI.

Fertilizers remain our biggest consumer of chemicals. Use of chemicals in fertilizers has grown more than 40 percent in the past five years. In the current fiscal year (ending June 30) production of nitrogen fertilizers will add up to 1,125,000 tons (N). Of this total only 40,000 will come from natural organics. During the 1949-50 fiscal year only 978,000 tons of N was made. Of that total 38,000 tons was from natural organic matter.

Phosphate fertilizer output in the same period will fall below the last fiscal year's level. Reason: cut back in sulphur allotments by sulphur producers. Department of Commerce estimates that production in this category will be down about 8 percent in terms of P_2O_5 content.

Potash fertilizers produced in this country will reach 1,250,000 tons K_2O in the 1950-51 year. This represents a gain of almost 15 percent over the previous year.

Pulp and paper remains our third largest consumer of chemicals. Consumption of chemicals in this process industry has jumped up 50 percent since the end of the war. Further growth can be expected as the industry steps in to fill the needs created by shortages of metal and demand for lighter packages. Backlog of unfilled orders in this industry almost doubled in the past year.

Petroleum production has risen steadily since the war and its chemical requirements have followed suit. The use of chemicals in petroleum refining is 36 percent above 1945 operating levels.

Paints and varnishes have been riding the crest of the building boom. Need for protective coatings has pulled the use of chemicals in the industry up 75 percent above 1945 rates. With the current emergency building up a vast new market this industries chief problem is raw material costs. Reason: Slack controls on vegetable oils and imported products.

Iron and steel industry is taking more chemicals each month as it pushes toward its new goal of 120 million tons of ingots and castings per year. Chemical use in this industry has grown more than 36 percent since the end of World War II. Experts figure that it will grow another 15 percent by 1952.

Rayon chemical use is running 53 percent ahead of wartime rates. Imports of yarn and staple fiber are moving in at the rate of 12 million pounds per month. This is twice as great as the early 1950 level. But producer stocks of yarn have dropped below last year's levels. However, some signs of a return to normal inventories have started to appear. Rayon remains one of the nation's big chemical consumers.

Glass has held up as a major chemical user although its growth has not been as rapid as some other chemical markets. Return of a metal shortage means good times ahead for glass containers.

Early this year container output was 2 billion units below World War II peaks. However, with present facilities we should be able to get more than 21 billion units per year if real scarcities of metal containers develop. This could mean an increase of 35 percent over 1950 rates in this part of the glass industry. Result: A sharp increase in chemical use.

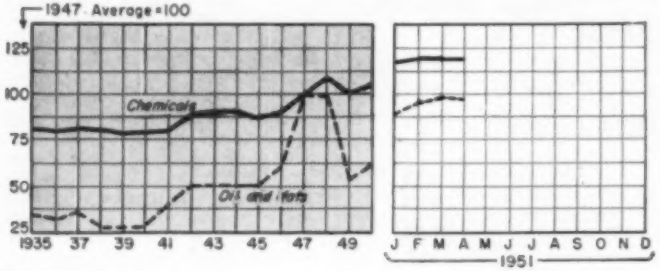
Plastics have been a fast growing market for chemicals since the end of the last world conflict. Currently growth of this market is being hampered by the shortage of basic chemical raw materials. Use of plastics as a substitute for metals is important. But this will be limited by the plastics manufacturers' supply of raw materials.

Textiles have upped the use of chemicals about a third since 1945. Use of more synthetic fibers and special treating processes for natural fibers will keep this industry high on chemical manufacturers lists of customers.

Other markets are contributing their share to the total output of the CPI. The accompanying list of big chemical markets was selected from major industrial chemical consuming industries represented in *Chemical Engineering*'s consumption index. The comparative periods used were 1945 and January 1951.

Process Industry Trends

PRICES

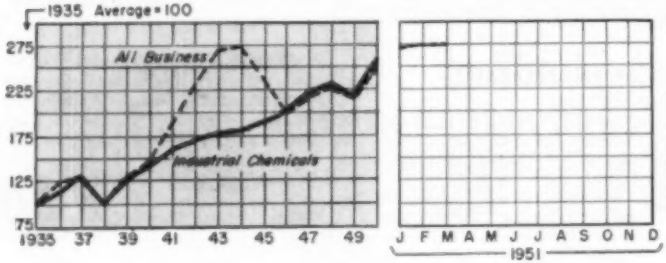


Chemical Engineering's Price Indexes

Chemicals — Up 0.13
Fats & Oils—Down 3.71

	Chemicals	Oils & Fats
As of May 1.....	119.11	93.19
Last month	118.98	96.90
May 1950	100.00	55.88
May 1949	101.38	53.53

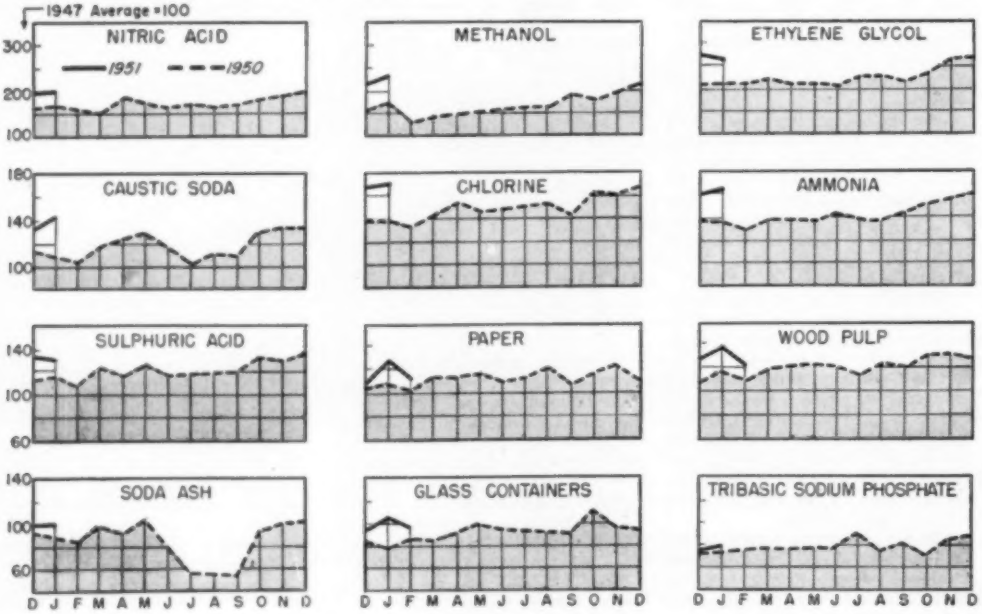
CONSUMPTION



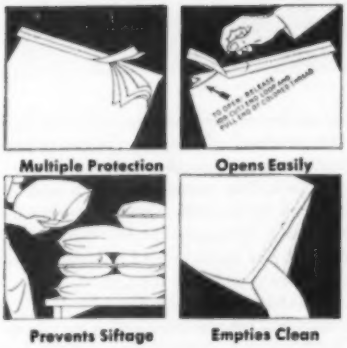
Industrial Chemicals Index

	January	February
Fertilizers	59.20	57.95
Pulp and paper.....	29.90	27.50
Petroleum refining ..	25.50	23.40
Iron and steel.....	16.40	14.25
Rayon	28.20	31.65
Glass	24.05	21.55
Paint and varnish..	30.79	28.80
Textiles	13.72	12.67
Coal products	11.08	9.90
Leather	4.37	4.13
Explosives	7.65	7.22
Rubber	6.24	5.55
Plastics	17.50	16.62
INDEX	274.60	261.19

PRODUCTION



The time has come the Walrus said To talk of many things of Ships and Planes... Production Pains and everything it brings



"EVERYTHING," in the national emergency, can include whatever you make and ship. Overnight it might mean changes in type of design of your containers.

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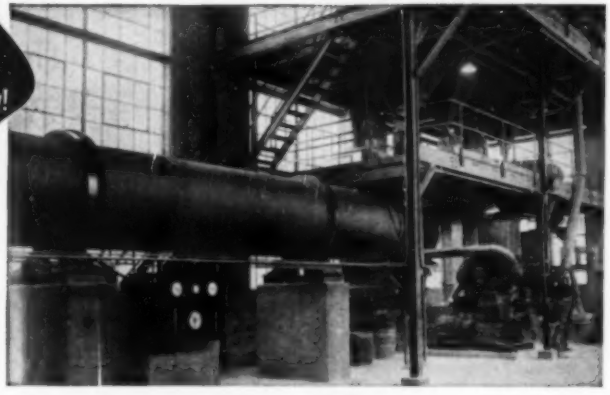

FORMER DRYER

Installed cost $32,000
Drying time ..... 300 minutes
Drying cost ..... $1.42 per 100 lb.
(space required, 2,000 sq. ft.)

LOUISVILLE DRYER

Installed cost $78,000
Drying time ..... 25 minutes
Drying cost ..... $0.415 per 100 lb.
(space required, 900 sq. ft.)

YEARLY SAVINGS OF LOUISVILLE DRYER IN OPERATING COSTS ALONE . . . $40,000

Sometimes the cheapest drying methods are the most expensive!

Take the case of this producer of synthetic resin for plastics. His situation was studied by a Louisville engineer who uncovered this fact: by investing *more* money in a Louisville Dryer—especially designed for the job—savings would more than write off the cost of the new equipment in less than 2 years. In addition, total enclosure of the material to be dried would mean no contamination from airborne dust, dirt. Speeded-up drying time improved product quality.

Tests in our own research laboratories and pilot plant predetermined the performance of this custom-built dryer. Have a Louisville engineer survey your drying methods. No obligation. Write today.

Ask for new treatise on subject of rotary dryers

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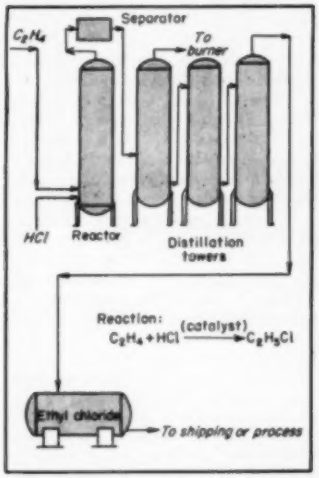
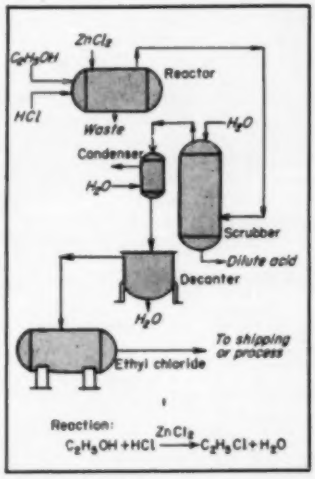
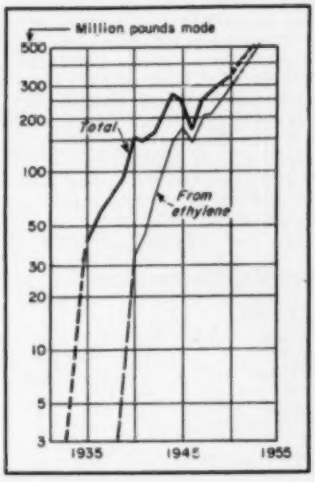


From ethylene . . .



From ethyl alcohol . . .



. . . Growing output.

Ethyl Chloride

Tied to the skyrocketing demand for tetraethyl lead, output has doubled in the past ten years. It is a growing ethylene market.

Ethyl chloride's growth—like a host of other organics—is tied to the automobile industry. Reason: Its biggest market is the production of tetraethyl lead which is used in anti-knock compounds. In fact the largest producer, Ethyl Corp., was set up to supply the demand for this product in gasoline. In supplying its largest customer, ethyl chloride has no competition from other products. This is also true in the case of its second largest market—ethyl cellulose. However, from a tonnage viewpoint tetraethyl lead has created the market that keeps this chemical growing. The accompanying table, based on data published recently proves this conclusively.

TEL Plant Capacity

Year	Million Lb.
1952 (est)	525
1951 (est)	420
1950	350
1945	296
1944	259
1943 }	221
1941 }	

Since the largest amount of ethyl chloride ends up in TEL it is not surprising to find that the largest producer is Ethyl Corp. Out of our 1951 capacity of more than 415 million pounds, Ethyl Corp. is expected to make 265 million pounds at Baton Rouge, La. Ethyl is now building a new unit at Houston, Tex., which will further expand output in the near future. Dow Chemical Co. also produces ethyl chloride. It is the country's second largest producer. Dow has plants at Midland, Mich., and Freeport, Tex. These plants have an estimated capacity of 100 million pounds per year. Third largest producer is Shell Chemical Corp. Its Houston plant will turn out more than 50 million pounds in 1951. This plant went on stream in 1948.

Du Pont and Hercules Powder Co. also have plants which can produce ethyl chloride. Du Pont can make it at Deepwater Point, N. J. Hercules can produce it at its Hopewell plant in connection with its ethyl cellulose operations. Both of these units use ethyl alcohol as a raw material. In 1948 they are reported to have produced 70 million pounds of ethyl chloride. One of the units at Ethyl's Baton Rouge plant uses ethyl alcohol. Here it is used only to supplement the production by the ethylene unit.

In 1950 fiscal year the government reports that ethyl chloride production from ethyl alcohol was 60,000,000 lb.

There are three ways to make ethyl chloride commercially. In actual practice only two have been widely used and only one is used by several firms at the present time.

Alcohol Plus HCl—Oldest commercial process is the reaction of the ethyl alcohol and HCl. Ethyl Corp. has used this process. So has Du Pont and Hercules Powder Co. In this process ethyl alcohol and Hcl are first introduced in a reactor which operates under about 2 atm. pressure and into which a catalyst has been added. Zinc chloride in the form of an aqueous solution can be used as the catalyst. Dry HCl is fed into the reactor in the zinc chloride solution at about 290 deg. F. The ethyl alcohol is added from the bottom of the reactor, countercurrent to the HCl–zinc chloride solution. The catalyst concentration is kept constant while the vapors of the ethyl chloride, water and some HCl are withdrawn and passed through a countercurrent glass-lined scrubbing tower where water at 176 deg. F. removes the acid. The scrubbed vapors are cooled to room temperature in a condenser. Both scrubber and condenser are operated under pressure (approximately 2 atm.). Under these conditions the water and ethyl chloride are condensed and passed to a decanter where the ethyl chloride is drawn off. This process has yields of more than 95 percent ethyl chloride.

(*Continued*)

In this process the catalyst loss is small. To produce a 1,000 lb. of product about 750 lb. of alcohol is consumed and 600 lb. HCl is used. At current market prices for large quantities of synthetic ethyl alcohol and hydrochloric acid this means that the raw materials cost at least $96-97 per 1,000 lb. of product. With fermentation alcohol the raw material cost will jump to more than $132 per 1,000 lb. of ethyl chloride. Ethyl chloride is now quoted in tanks at $100 per 1,000 lb. This means that raw material costs (if considered at current market prices) would force this process out.

Ethylene Plus HCl—Biggest process in current production of this chemical is the reaction of ethylene with HCl to form ethyl chloride. This process is now employed by all big producers. Here is the way it works.

Ethylene and hydrogen chloride are fed to a reactor. There (in the presence of a catalyst such as $AlCl_3$) an addition reaction forms ethyl chloride. The raw materials are fed to the reactor in a mixed stream. The reaction is carried out in a liquid or vapor state. Under current commercial practice the reactor operates under about 2 atm. pressure and at a temperature in the range of 95-105 deg. F.

The reaction takes place more readily if liquid catalysts are used. Therefore, solid catalysts are either fused or dissolved in a solvent or ethyl chloride. In this process, 90 percent yields are reached.

Cost factors involved in producing chemicals like ethyl chloride can be deceiving because allocation of costs is often a bookkeeping operation. However, by charging in the hydrogen chloride at a nominal fee and ethylene at 4.5 c. per lb. the cost of operation in an integrated plant can be determined. A sales price of 10 c. per lb. and approximately 3.7 man-hours per ton for labor were used in working out the accompanying cost estimation.

This breakdown does not represent any particular plant's operation. It does show the approximate allocation of expenses in the production of ethyl chloride by the ethylene process.

Ethane Plus Chlorine—Ethyl chloride can be made from the reaction of ethane and chlorine through the use of three techniques. They involve thermal, catalytic, photochemical means. At temperatures of 644 deg. F. the chlorination of ethane takes place without the use of a catalyst or light. However, polychlorides are formed. The degree of polychlorination can be controlled to some extent by the ratio of ethane to chlorine feed and the reaction time. —End

Estimated Cost Factors

	C. per Lb.
Raw materials	4.3
Labor	0.3
Supervision	0.1
Maintenance	0.8
Power	0.5
Depreciation	0.8
Overhead	0.4
Plant cost	7.2
Administration, etc.	0.5
Gross profit	2.3
Price	10.0

Materials Balance

Raw materials, lb./M lb. C_2H_5Cl	
Ethylene	488
HCl	625
$AlCl_3$	270

Plant, Process and Capacity

Firms and Locations	Process[1]	Capacity (Million Lb. per Yr.)
Dow Chemical Co.		
Midland, Mich.	E	
Freeport, Tex.	E	100
Du Pont Co.		
Deepwater Point, N. J.	A	[4]
Ethyl Corp.		
Baton Rouge, La.	E	260
Houston, Tex.	E	[3]
Shell Chemical Corp.		
Houston, Tex.	E	50
Hercules Powder Co.		
Hopewell, Va.	A	[4]

[1] E = Ethylene; A = Alcohol. [2] Not available. Plant runs intermittently to balance TEL operations. [3] Under construction. [4] Not running.

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. . .

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120'-diameter steel-tank Hardinge Clarifier removing 60 tons per hour of solids from coal breaker waste water.

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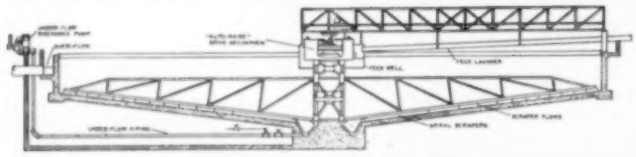

Cross section of a Hardinge concrete-tank Thickener

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If you're looking for unusual rigidity *and* toughness in plastics, you'll want to look into Naugatuck's new Kralastic styrene copolymers. Read what Kralastic has done in this tough pipe-line job, then send the coupon below for your *free* experimental samples and full technical data on the specific advantages Kralastic can bring to *your* product.

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Kralastic provides all these advantages with *outstanding durability* (it is not brittle). Yet Kralastic is *more economical* than chemically resistant metal pipe, *readily cementable* using ketones, and *extremely light and easy to handle.*

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New Construction

Proposed Work

Fla., Port St. Joe—Kraft Container Board Co., Port St. Joe, plans to enlarge its plant here. Estimated cost $24,011,000

Ind., Gary—Wood River Refining Co., Wichita, Kan., plans to construct a catalytic cracking plant here. Estimated cost $7,000,000

La., Lake Charles—Continental Oil Co., Oil & Gas Bldg., Houston, Tex., plans to construct a modern refinery here. Estimated cost $10,000,000

S. C., Rock Hill—Celanese Corp. of America, Rock Hill, plans to construct an addition to its plant. Estimated cost $20,000,000

Tex., Bishop—Celanese Corp. of America, 180 Madison Ave., New York City, plans to construct a chemical plant here. Estimated cost $8,500,000

Tex., Phillips—Phillips Petroleum Co., Phillips, plans to construct new propane and butane refinery. Estimated cost $4,056,575

Tex., Port Arthur—Gulf Oil Corp., Port Arthur, plans to construct new refinery. Estimated cost $18,485,342

Tex., San Antonio—Carroll B. Fulton and H. W. Olmstead, San Antonio, plan to construct aviation gasoline plant. Estimated cost $11,925,000

Utah, Salt Lake City—Phillips Petroleum Co., Bartlesville, Okla., plans to construct a catalytic cracking plant. Estimated cost $10,000,000

Contracts Awarded

Ala., Birmingham—B. F. Goodrich Co., c/o Brice Building Co., P. O. Box 1028, Birmingham, contractor, will construct a warehouse and office. Estimated cost $100,000

Ala., Ragland—Ragland Brick Co., Ragland, has awarded the contract for a brick manufacturing plant to Brice Building Co., P. O. Box 1028, Birmingham. Estimated cost will exceed $2,000,000

Calif., San Pedro—Union Oil Co. of California, 617 West 7th St., Los Angeles, has awarded the contract for a catalyst storage hopper and slurry tank to A. G. McKee & Co., 2300 Chester Ave., Cleveland, O., at $1,057,100

Fla., Mulberry—International Minerals & Chemical Co., Mulberry, will enlarge its chemical plant here. Work will be done with own forces. Estimated cost $6,000,000

Ga., Savannah—Union Bag & Paper Corp. c/o Morton C. Tuttle Co., 862 Park Sq. Bldg., Boston, Mass., contractor, will construct a plant addition. Estimated cost will exceed $300,000

Ind., Noblesville—Firestone Tire & Rubber Co., Akron, O., has awarded the contract for a warehouse to Carl Geupel Construction Co., 1919 North Meridian St., Indianapolis. Estimated cost $270,000

	Current Projects		Cumulative 1951	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	.....	.....	.....	$415,000
Middle Atlantic	.....	$13,000,000	$1,500,000	49,149,000
South	$54,011,000	40,100,000	72,311,000	202,633,000
Middle West	7,000,000	5,270,000	27,625,000	86,300,000
West of Mississippi	42,967,000	92,058,000	144,267,000	238,272,000
Far West	10,000,000	2,229,000	15,750,000	9,734,000
Canada	.....	.....	116,577,000	38,336,000
Total	$113,978,000	$152,657,000	$378,030,000	$585,839,000

Ky., Calvert City—National Carbide Co. (Division of Air Reduction Co., Inc., 60 East 42nd St., New York City), has awarded the contract to design and construct a calcium carbide plant on the Tennessee River, to United Engineers & Constructors, Inc., 1401 Arch St., Philadelphia, Pa. Estimated cost $10,000,000

Ky., Danville—Corning Glass Works, 718 Fifth Ave., New York, N. Y., has awarded the contract for a glass plant here to Ditmars-Dickman-Pickens Construction Co., Muskogee, Okla. Estimated cost $2,000,000

Ky., Louisville—Cochran Foil Co., 1430 South 13th St., has awarded the contract for a 1-story plant addition to Sullivan & Cozzart, 822 West Kentucky St. Estimated cost $200,000

La., Belle Chasse—Red Star Yeast & Products Co., c/o Farnsworth & Chambers, P. O. Box 74, Houston, Tex., contractors, will construct a yeast manufacturing plant here. Estimated cost $1,500,000

Md., Baltimore—General Refractories, 1520 Locust St., Philadelphia, Pa., will remodel its refractories plant here. Work will be done with separate contracts. Estimated cost $2,000,000

Mo., Crystal City—Pittsburgh Plate Glass Co., Crystal City, has awarded the contract for an addition to its plant for the manufacture of automotive glass to Fruin-Colnon Contracting Co., 1700 Olive St., St. Louis

Mo., Kansas City—American Asphalt Roof Corp., 7600 Truman Rd., has awarded the contract for a dry felt mill to Winn-Santi. Construction Co., Railway Exchange Bldg. Estimated cost $750,000

Mo., North Kansas City—Clorox Chemical Co., 850 42nd Ave., Oakland, Calif., has awarded the contract for a plant here to Universal Construction Co., Scarritt Bldg., Kansas City. Estimated cost $400,000

N. J., Deepwater Point—E. I. du Pont de Nemours & Co., Inc., Du Pont Bldg., Wilmington, Del., will modernize and enlarge its plant here to increase facilities for the manufacture of "Ponsol" dyes. Work will be done with own forces. Estimated cost $1,000,000

N. J., Manville—Johns-Manville Corp., 22 East 40th St., New York City, has awarded the contract for a laboratory and semi-works building addition to J-M Research Center to Turner Construction Co., 420 Lexington Ave., New York 17, N. Y. Estimated cost $2,000,000

O., Silica—Medusa Portland Cement Co., Midland Bldg., Cleveland, has awarded the contract for an addition to its cement mill to A. Bentley & Sons Co., 201 Belmont St., Toledo. Estimated cost $2,500,000

Ore., Salem—Oregon Pulp & Paper Co., Salem, has awarded the contract for a 2-story addition to its wood pulp plant to Austin Co., 2930 4th Ave., S., Seattle, Wash. Estimated cost $750,000

Pa., Erie—Hammermill Paper Co., East Lake Rd., has awarded the contract for alterations and additions to its plant to Sessinghaus & Ostergard, 1115 Peach St. Estimated cost $1,000,000

Tex., Fort Worth—Armour & Co., North Fort Worth, has awarded the contract for a medicinal plant (plasma) to Thomas S. Byrne, 1st Natl. Bank Bldg., Fort Worth. Estimated cost $850,000

Tex., Freeport—Dow Chemical Co., Freeport, has awarded the contract for a new caustic soda plant to Foster-Wheeler Corp., Shell Bldg., Houston. Estimated cost $3,750,000

Tex., Freeport—Dow Chemical Co., Freeport, will rehabilitate government-owned magnesium plant here. Work will be done with purchase and hire. Estimated cost $2,750,000. Company awarded contract for extensions and additions to Ethyl plant to Tellepson Construction Co., 1710 Telephone Rd., Houston. Estimated cost $2,750,000

Tex., Gregory—Reynolds Metals Co., Hunt Bldg., has awarded the contract for an aluminum plant to Henry C. Beck Co., Irwin Keasler Bldg., Dallas, and H. R. Henderson & Co., Marshal, Tex. Estimated cost $80,000,000

Tex., Houston—Ethyl Corp., Ship Channel, has awarded the contract for a central shop, plant and storage building to Fretz Construction Co., 2000 Eastwood St. Estimated cost $725,748

Utah, Butlerville—Whitmore Oxygen Co., 430 E. South Temple St., Salt Lake City, will enlarge its oxygen and hydrogen plant here. Work will be done with own forces. Estimated cost $250,000

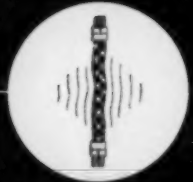
Wash., Tacoma—Penn Salt Manufacturing Co., 2901 Taylor Way, has awarded the contract for an addition to its chemical plant to Roy T. Early Co., 321 Middle Waterway. Estimated cost $172,000

W. Va., New Haven—Vanadium Corp. of America, 420 Lexington Ave., New York City, will construct a silicon alloys plant here. Work will be done by owner. Estimated cost $7,000,000

Wis., Manitowoc—Manitowoc Cement Co., Manitowoc, will construct additions to its cement plant. Work will be done with separate contracts. Estimated cost $2,500,000

Titeflex

ALL-METAL FLEXIBLE TUBING



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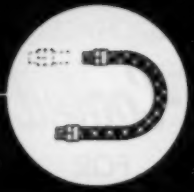

FOR FLEXING

FOR MISALIGNMENT

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- ★ Made in five metals—brass, bronze, stainless, Monel, Inconel.
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for End Brick Replacement!

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FOR
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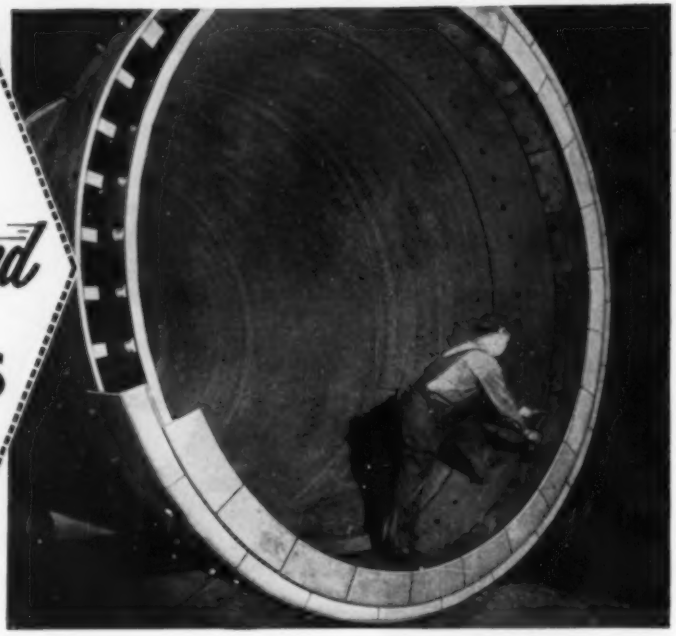

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Result: No kiln warpage; refractory brick lasts as long at discharge end as at any point along the kiln.

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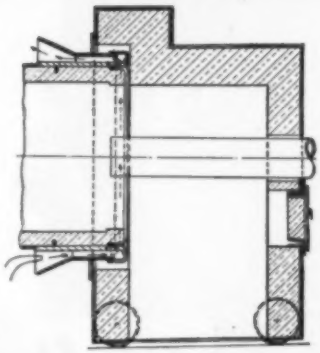
Air-cooled kiln end design makes possible the use of a more positive air seal, resulting in fuel savings.

Other important features of Allis-Chalmers rotary kilns:

- **Extra thick shell at discharge end and under riding rings.**
- **Centralized instrument control of the entire operation.**
- **Modern heat recuperation equipment. Constant delivery feeders and all auxiliary kiln equipment.**

Get more facts from the A-C representative in your area, or write for **Bulletin 07B6368.** Allis-Chalmers, Milwaukee 1, Wisconsin. A-3281

Texrope is an Allis-Chalmers trademark.



Sketch shows arrangement of movable firing hood with air-cooled kiln end.

ALLIS-CHALMERS

Sales Offices in Principal Cities in the U. S. A. Distributors Throughout the World.

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Controls

Texrope Drives

Vibrating Screens

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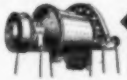
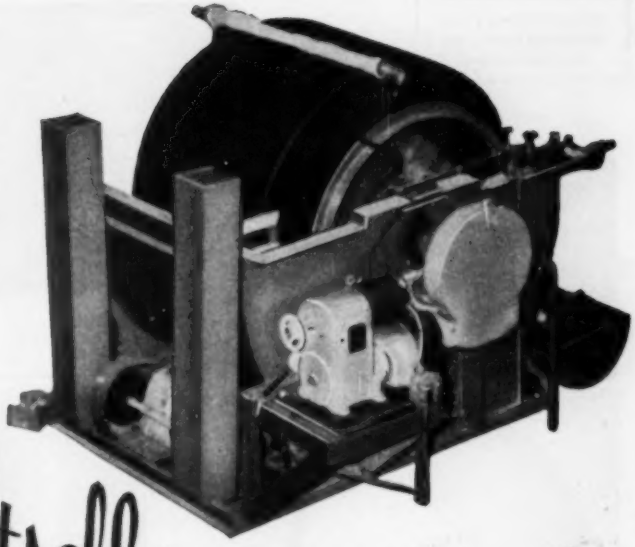


Grinding Mills

FEinc CONTINUOUS FILTER



Paid for Itself in 3 Months

By delivering a filtrate clear enough to recycle, a FEinc String Discharge rotary vacuum filter saved enough in three months on water alone to pay for itself. This manufacturer of plastic products originally used six concrete settling tanks to recover cellulose acetate grinding waste. The dirty effluent was dumped down the sewer. Now a FEinc high-submergence filter recovers all the valuable plastic, and saves the filtrate too! The String Discharge picks the cake cleanly from the cloth in one continuous sheet, supported by strings. No smearing or blinding of the cake, no scraper wear or compressed air blow-back.

FEinc's Compression Dewatering pays off handsomely, too, by squeezing 2-6% more of the moisture out of the cake. Like the case where a FEinc unit replaced a scraper filter on hydrated alumina, removed 400 lbs. more water per hour, eliminated sticky fines, and permitted use of a more efficient conveyor type dryer.

If it's clean cake or high soluble recovery you want, look to the FEinc submergence washing mechanism. For instance, a FEinc washing filter now delivers a perfect pH 7 in a cake that couldn't be washed better than pH 5 on a competitive filter.

Any combination of FEinc features can be built to make your toughest filtering, washing, drying and cake-handling seem easy. Pilot Plant filters available on rental-purchase plan for try-outs or small production work.

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Complete details in Bulletin 103. Send for it today—it's free.

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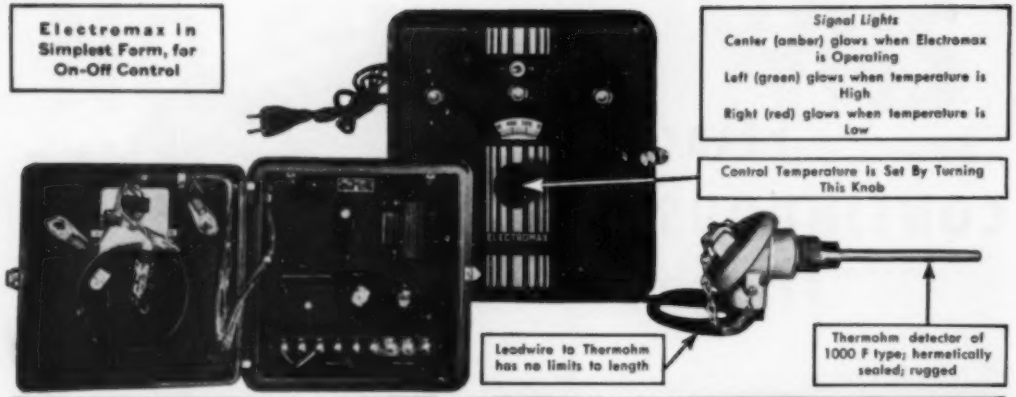
Electromax in Simplest Form, for On-Off Control
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Center (amber) glows when Electromax is Operating
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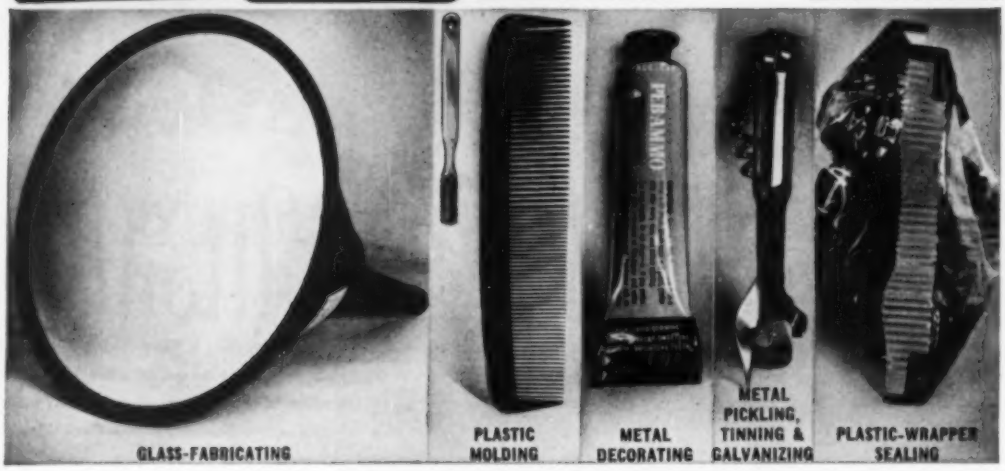
Control Temperature is Set By Turning This Knob
Leadwire to Thermohm has no limits to length
Thermohm detector of 1000 F type; hermetically sealed; rugged



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ELECTROMAX CONTROLLERS give modern *electronic* regulation to thousands of important manufacturing processes. They exactly fill the bill for non-recording controllers of outstanding dependability.

Electromax has the sensitivity, accuracy and dependability of its big brother Speedomax Recording Controller. Likewise, it is not affected by vibration or building tremors—can even be mounted on the frame of a molding press. The instrument needs almost no attention, because it has only one moving part —a covered, plug-in type relay. There's usually no need to open its door for months at a time.

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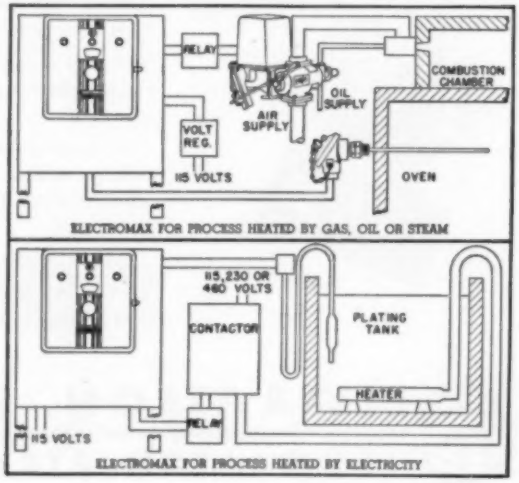

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Jrl. Ad ND47(1)

Stokes Freeze-Drying equipment in operation at E. R. Squibb & Sons' New Brunswick, N. J., plant. Such equipment is widely used for the drying of blood plasma, streptomycin, ACTH, and other vitally needed chemical and pharmaceutical products.

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This famous quotation has identified Squibb products and principles for more than a quarter of a century.

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Earning first the respect of the medical profession, Squibb laid the foundation for public acceptance and repute now worldwide.

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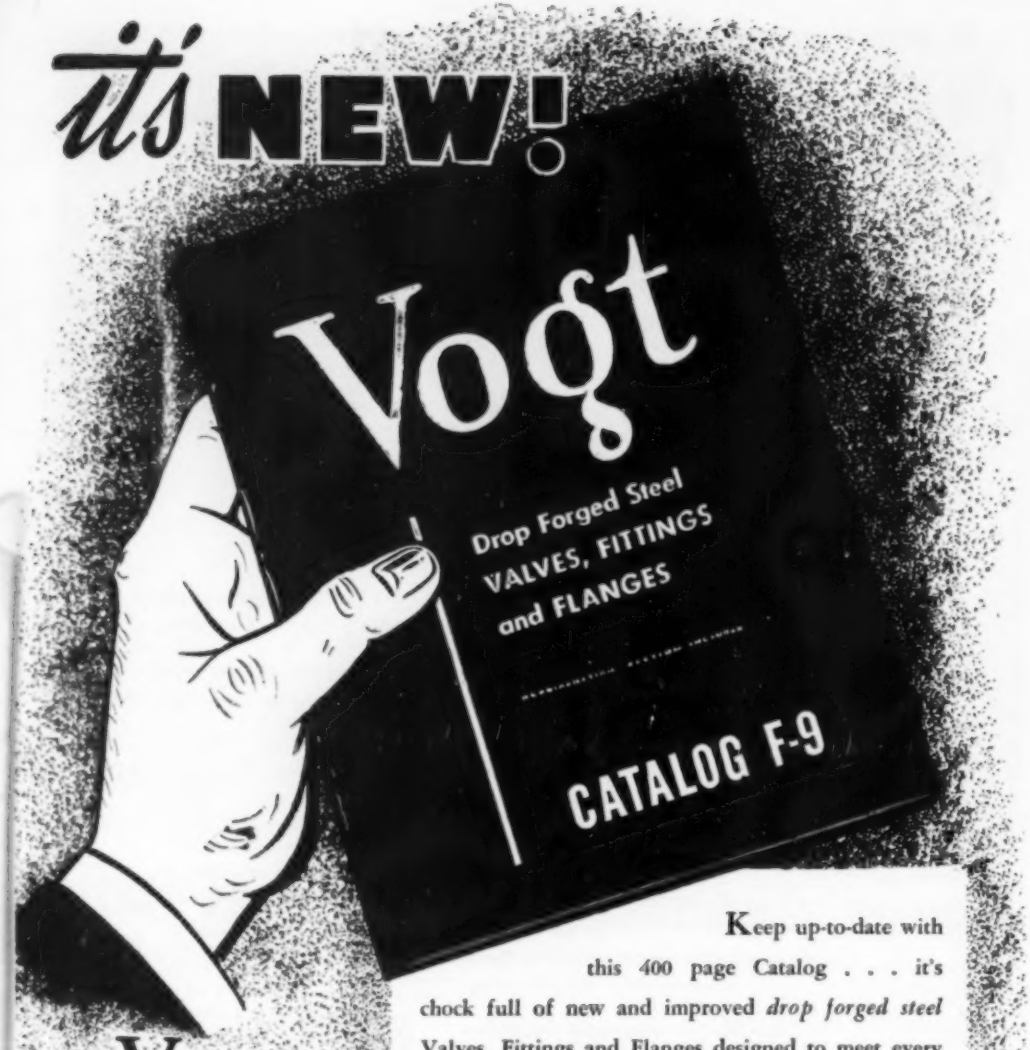

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Air View of Vogt Plant

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LOUISVILLE 10, KENTUCKY
BRANCH OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va.

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by ESCO

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Precision-made for accurate alignment
Properly proportioned
Rigidly inspected and tested for long service.

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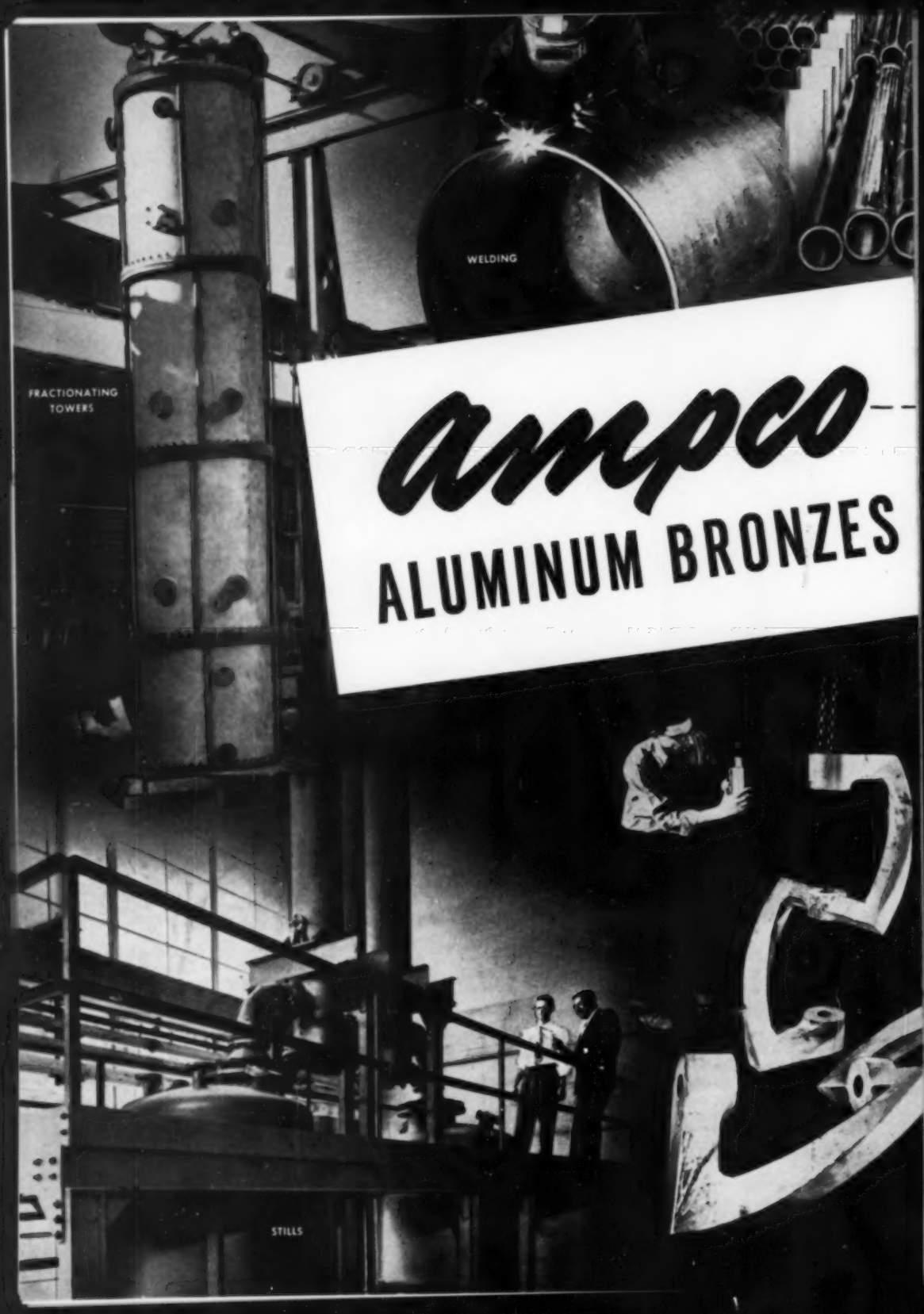
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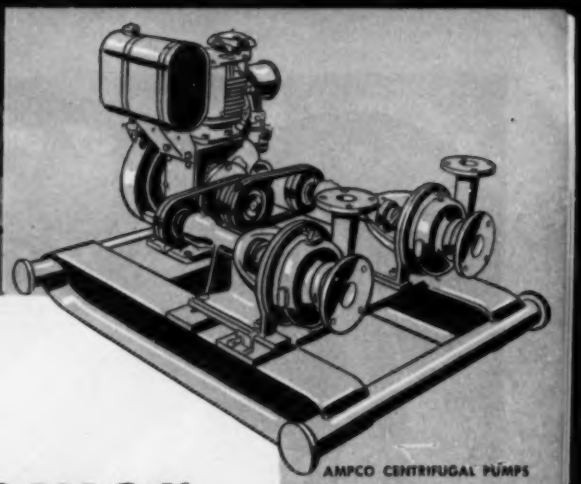

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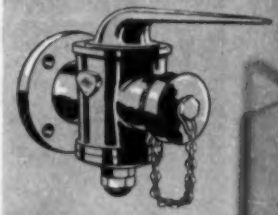
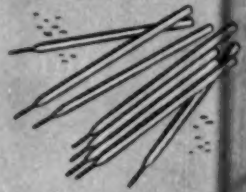
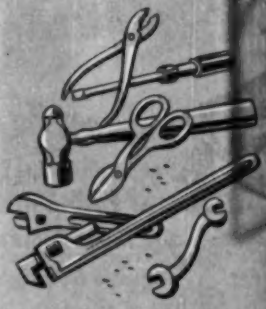


AMPCO PLUG VALVES



AMPCO BRONZE ELECTRODES



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Ampco Metal Grade 8 is an annealed alpha aluminum bronze alloy conforming to ASTM B-169-50T Alloy D. It is approved for use in the construction of unfired pressure vessels. See your Boiler Code Handbook — paragraphs U-68 and U-69 as interpreted in case No. 1108 — for complete details.

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PR-4

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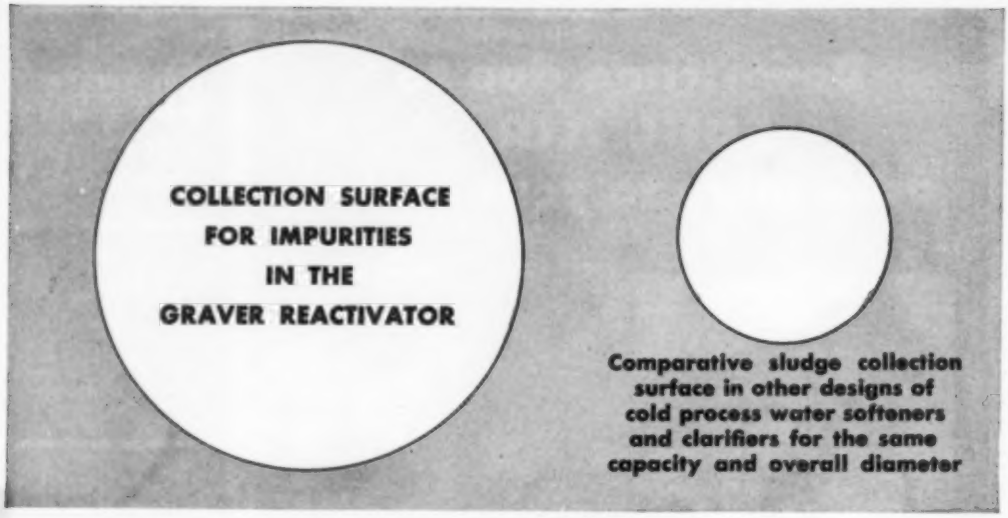
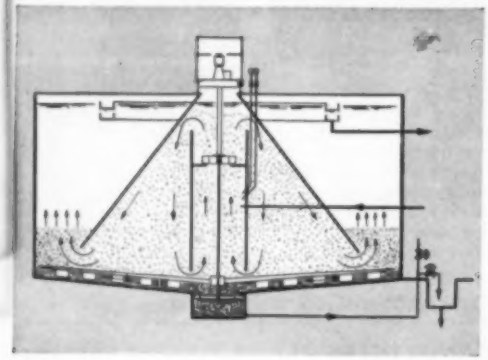

COLLECTION SURFACE
FOR IMPURITIES
IN THE
GRAVER REACTIVATOR
Comparative sludge collection surface in other designs of cold process water softeners and clarifiers for the same capacity and overall diameter

4 Times the Area

for collecting impurities in the GRAVER REACTIVATOR



The Graver Reactivator is the *only* cold process water softener and clarifier in which the *entire bottom* is used for the settling and collection of the precipitated impurities and sediment in the water.

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And these are only a few of the many distinctive advantages of the Graver Reactivator. The whole story is presented in our bulletin W-103, which every engineer should have. Your copy will be sent upon request without obligation on your part.

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GW-429

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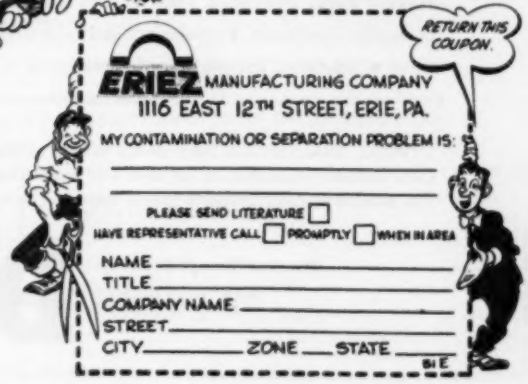

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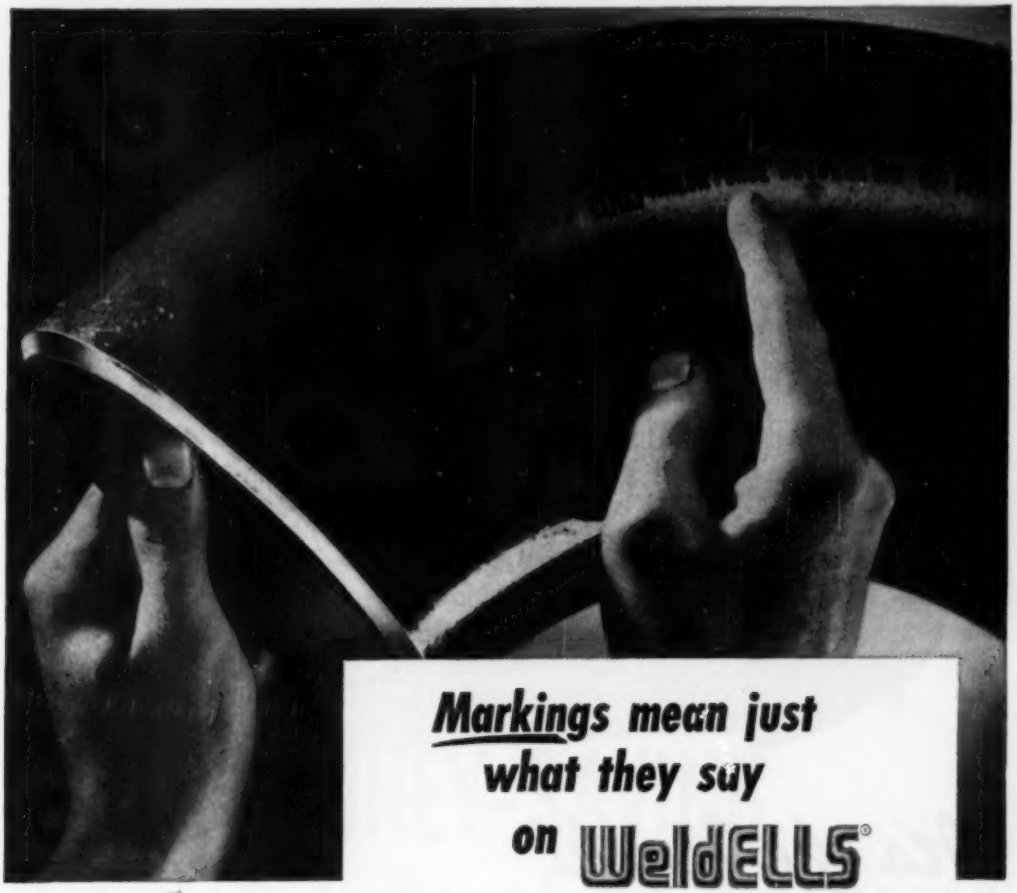

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It's the Nash!

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

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Nash Compressors produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods. Data on these pumps sent immediately on request

- No internal wearing parts.
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- Desired delivery temperature automatically maintained.
- Slugs of liquid entering pump will do no harm.
- 75 pounds in a single stage.

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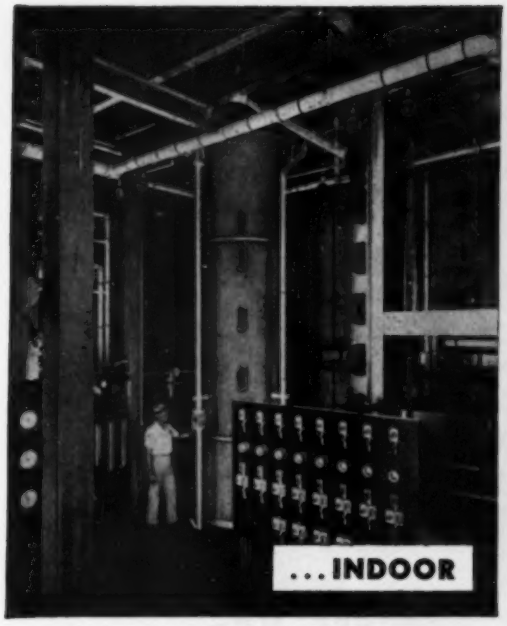
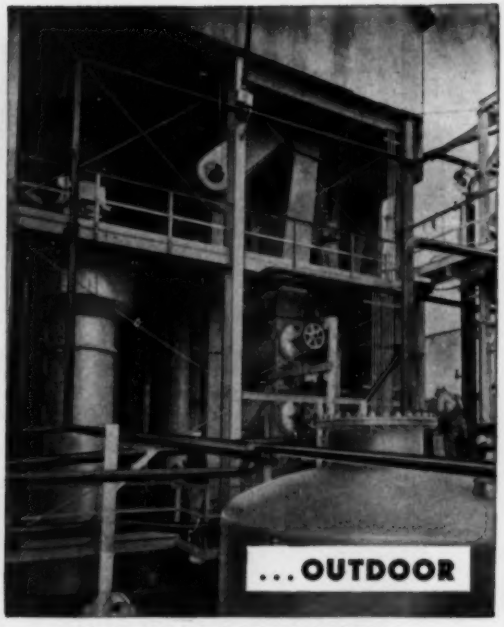


Soy bean oil extraction plant located in Tennessee



Rice bran oil extraction plant in Southern Texas

ALLIS-CHALMERS GIVES YOU MONEY-SAVING Solvent Extraction Systems

WHEN YOU CALL on Allis-Chalmers for a continuous solvent extraction installation, you get a plant that's *individually designed* for your own particular application.

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Most climates call for a totally-enclosed installation . . . to protect workmen and machinery against snow and cold weather. Warmer climates permit the planning of an outdoor installation . . . with only a portion of the machinery being sheltered. Allis-Chalmers has designed and supervised the erection of continuous solvent extraction equipment for both indoor and outdoor plants.

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It is an established fact that continuous solvent extraction equipment *pays for itself* in a few short years . . . by recovering 4 to 7 per cent *more* vegetable oil than can be obtained by screw press or hydraulic methods.

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Contact your nearby Allis-Chalmers sales office for complete details. Ask for bulletin 13B6757, a fact-filled guide to money-saving solvent extraction systems. If more convenient, write direct to Allis-Chalmers, Milwaukee 1, Wis.

A-2257

ALLIS-CHALMERS

Pioneers in the Field of Continuous Solvent Extraction

Chemicals

FOR THE NATION'S DEFENSE NEEDS

COUMARONE RESINS
PETROLEUM RESINS
ALKYLATED PHENOL RESINS
PLASTICIZING OILS
COAL-TAR SOLVENTS AND OILS
NEUTRAL AND SHINGLE STAIN OILS
RUBBER RECLAIMING OILS
CHEMICAL SPECIALTIES

THE NEVILLE COMPANY **NEVILLE** PITTSBURGH 25, PA.

Plants at Neville Island, Pa., and Anaheim, Cal. A39

HARBISON-WALKER

Plastic and Castable Refractories

LESS TIME OUT FOR FURNACE REPAIRS AND MAINTENANCE

MEANS MORE PRODUCTIVE HOURS

Because you can make furnace lining repairs effectively and quickly with Harbison-Walker CASTABLE and PLASTIC Refractories, "down" time losses are reduced to a minimum. Whether the job is one of normal planned maintenance or of emergency repairs, you will find in the complete line of Harbison-Walker Plastic and Refractory Castables, the type and class especially suited for your particular application. For various original constructions also, considerable savings in time, labor and cost are secured by the use of these monolithic materials in place of preformed brick and shapes.

H-W CASTABLES comprise all classes and fulfill the special needs for highest refractoriness and spalling resistance, strength, wear resistance and insulation.

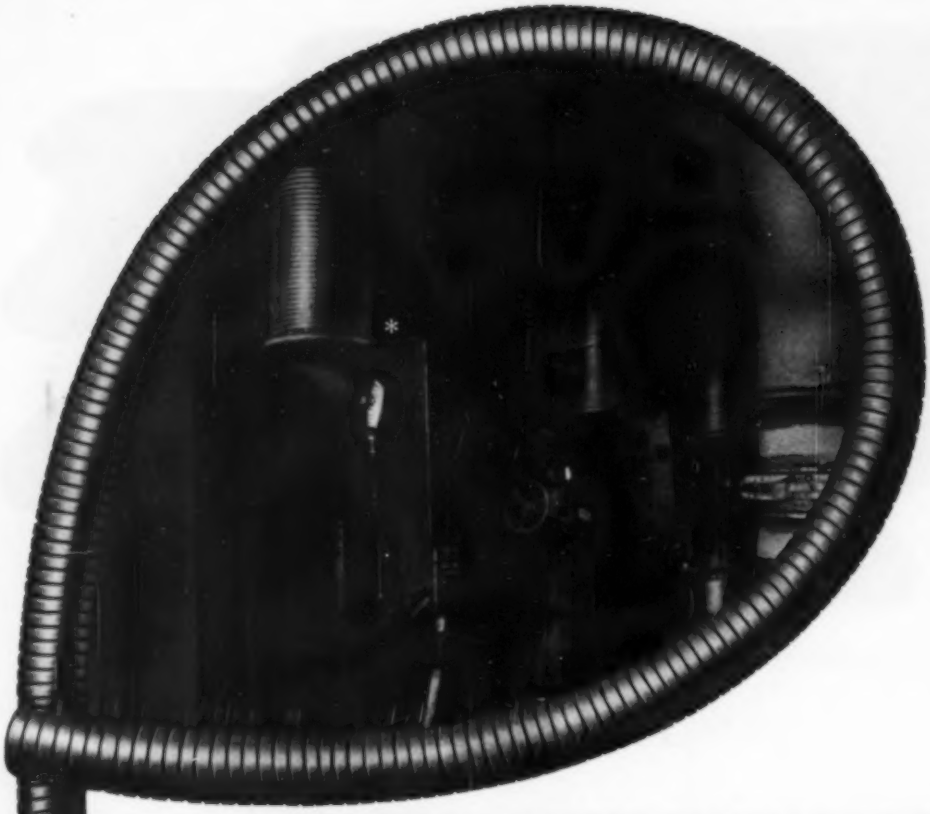
H-W PLASTICS as shipped are ready-prepared to the proper consistency for use by ramming into place. They are available in STANDARD and SUPER grades and are furnished in slabs easy to handle and apply.

WRITE for bulletin describing these products. It gives data and information for estimating your requirements.

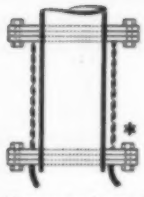
Harbison-Walker Refractories Company
AND SUBSIDIARIES

World's Largest Producer of Refractories

GENERAL OFFICES . . . . . PITTSBURGH 22, PENNA.



HELPS "PIPE DANCE" IN BOILER OPERATION



(Cross-sectional view, showing Penflex tubing encasement on steel feed pipes from hopper.)

PENFLEX TUBING ABSORBS THERMAL EXPANSION

When a large public utility power plant fed powdered coal into burners of high-pressure steam boilers, thermal expansion moved steel feed tubes around, showering coal dust over equipment.

Penflex tubing was recommended as an outer protective encasement for the rigid steel tube that comes down from the hopper. Lengths of 20" & 24" I. D. interlocking, galvanized steel tubing were installed. Now the steel pipes from the hopper virtually "float" at one end when thermal expansion occurs. Penflex tubing forms a flexible seal between hopper and tube, assuring protected delivery of powdered fuel.

Let Penflex engineers help you on flexible tubing application problems. Penflex manufactures a complete line of four wall, interlocking and seamless welded corrugated flexible tubing . . . metallic hose, tubing or couplings from ⅛" I. D. and up . . . automatic barrel fillers, pneumatic rivet passers, accessories and fittings. Write for folder, "Flexineering," a valuable production aid.

Pennsylvania Flexible Metallic Tubing Company, Inc., 7234 Powers Lane, Phila. 34, Pa.
Branch Sales Offices: **Boston • New York • Chicago • Houston • Cleveland • Los Angeles**

penflex

HEART OF INDUSTRY'S LIFE LINES

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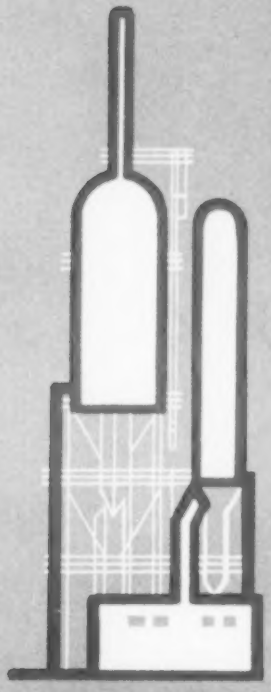
fluid catalytic cracking



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model IV

Possessing all the process and operating advantages of the basic "fluid" cracking principle and representing the lowest cost fluid unit per barrel output of high octane product with no sacrifice in engineering standards of safety and with improved operability and maintenance,—this truly new Standard Oil Development design, Model IV, is now available in any capacity to refiners,—anywhere in the world.

For further information, address your inquiries to:

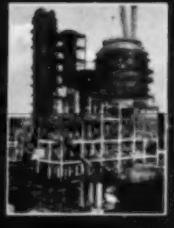
FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, NEW YORK

designers and builders of

fluid catalytic cracking units

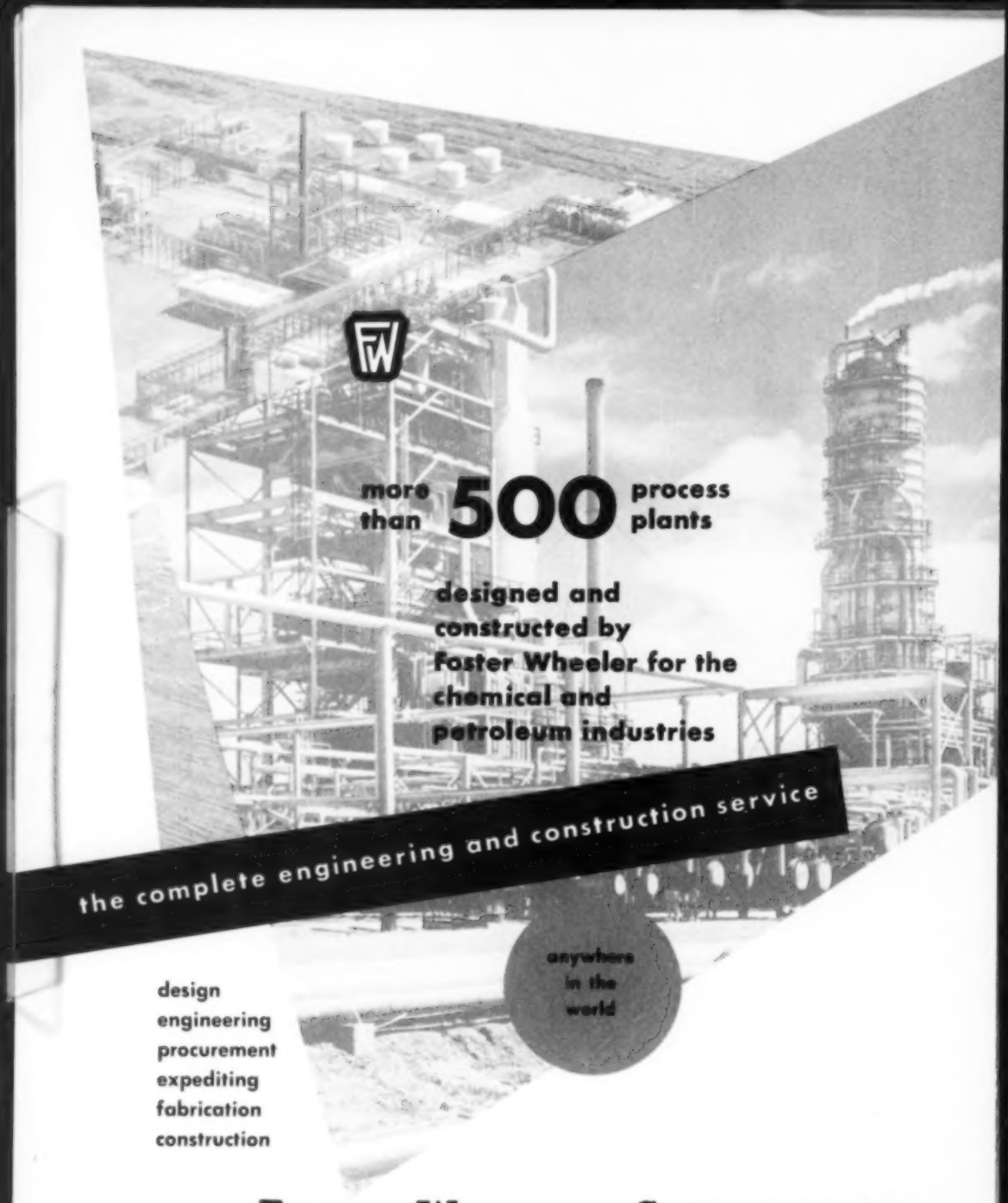
since 1941



now under construction by FW

built by FW in 1944

built by FW in 1941



more than **500** process plants

designed and constructed by Foster Wheeler for the chemical and petroleum industries

the complete engineering and construction service

anywhere in the world

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A FOOTE BROS. DRIVE

FOR ANY POWER TRANSMISSION NEED

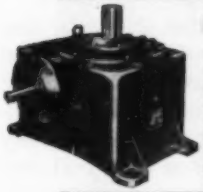
Any requirement for power transmission equipment can be met from Foote Bros. complete line of enclosed gear drives.

Nearly a century of engineering and manufacturing experience is back of these drives. Three large plants contain the newest in gear cutting equipment. New techniques in manufacture—better control of materials—improved manufacturing methods—all assure superior enclosed gear drives. Mail the coupon below for bulletins in which you are interested.

LINE-O-POWER

Economical in original cost and operation, these drives incorporate Duti-Rated Gears which have file-hard tooth services and ductile cores, assuring long life. Compact in design. Available in double or triple reductions, with ratios from 5 to 1 up to 238 to 1 and capacity range from 1 up to 200 horsepower. Write for Bulletin LPB.

VERTICAL DRIVES

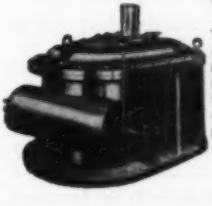


HYGRADE

A quality line of heavy-duty drives, incorporating precision worm gearing that assures high efficiency and load-carrying capacity. Vertical output shaft may extend upward, downward or both. Ratios from 4½ to 1 up to 4,108 to 1. Capacity up to 260 horsepower. Write for Bulletin HGA.

HYTOP

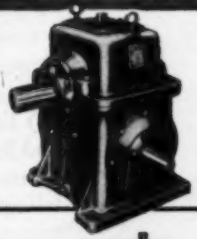
Similar in design to the Hygrade Vertical Drives, but with wider, low-speed bearing span to accommodate long, unsupported vertical output shaft extensions. Vertical output shaft may extend upward, downward or both. Write for Bulletin HGA.



WORM-HELICAL

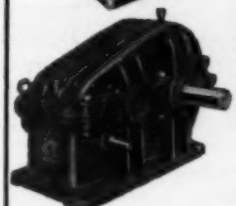
These drives are admirably suited to applications which require horizontal input and vertical output shafts for heavy-duty service. Available in ratios from approximately 30 to 250 to 1 and a capacity range up to 120 horsepower. Write for information.

HORIZONTAL DRIVES



HYGRADE

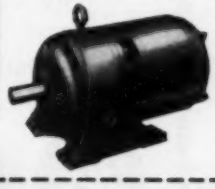
High quality, heavy duty, enclosed worm gearing that assures high efficiency and load-carrying capacity. Available in a wide range of types to meet any need. Ratios from 4½ to 1 up to 4,108 to 1. Capacity up to 260 horsepower. Write for Bulletin HGA.



MAXI-POWER

Heavy-duty helical gear drives. Available in single reduction units, ratios up to 9.91 to 1; capacities up to 1,550 horsepower; double-reduction units, ratios from 9.32 up to 71 to 1, capacities to 1100 horsepower; triple reduction units, ratios from 79 up to 360 to 1, capacities up to 420 horsepower. Write for Bulletin MPB.

FOOTE BROS.-LOUIS ALLIS *Gearmotors*



A compact line of gearmotors in 17 sizes in single, double and triple reductions, incorporating Duti-Rated Gears that assure long wear life and maximum load-carrying capacity. Units use Louis Allis high quality motors—available in a wide range of enclosures to meet any condition. Write for Bulletin GMA.

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Boulevard, Chicago 9, Illinois

FOOTE BROS.

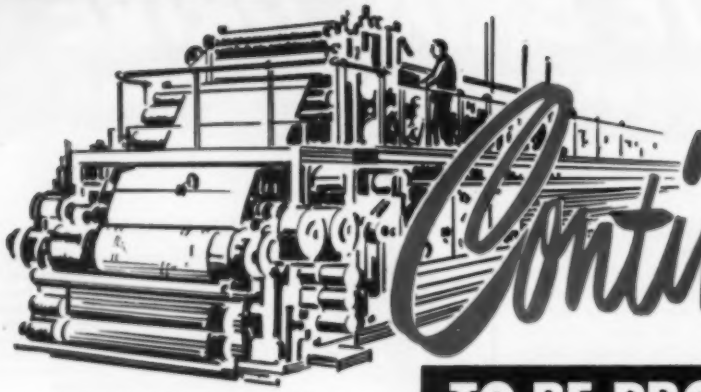
Better Power Transmission Through Better Gears

Foote Bros. Gear and Machine Corporation
Dept. CE, 4545 South Western Boulevard, Chicago 9, Illinois
Please send me the bulletins checked below:

- ☐ Bulletin HGA { Horizontal Hygrade / Vertical Hygrade / Vertical Hytop
- ☐ Bulletin LPB Line-O-Power
- ☐ Bulletin MPB Maxi-Power
- ☐ Bulletin GMA Foote Bros.-Louis Allis Gearmotors

Name.....*Position*.....
Company.....
Address.....
City.....*Zone*.....*State*.....

IT MUST BE *Continuous*



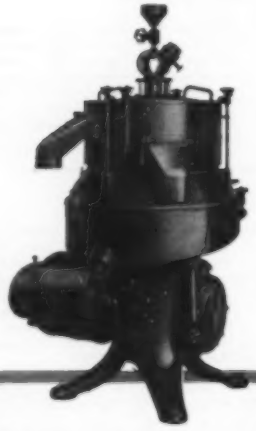
THE WHIRRING PRESSES OF A NEWSPAPER

TO BE PROFITABLE!

Chemical separation or clarification should be continuous, too, if it is to be truly profitable. De Laval centrifugal machines take the lost motion out of (1) liquid-liquid, (2) liquid-solid, or (3) liquid-solid-and-liquid separations by making each ***continuously*** by means of centrifugal force. Often De Laval centrifuges will do in seconds work that formerly took minutes by filters or hours by settling. Moreover, De Laval machines will continue to separate at constant efficiency throughout a long run—there is no need to stop to replace vital operating parts, as with some types of filters.

De Laval has many different types of machines that enable each application for centrifugal force to be met exactly. This is essential, for every liquid mixture presents its own problems of specific gravity, viscosity and, in some cases, solids that differ greatly in type and concentration.

Outline your problem to De Laval.



Why De Laval?

De Laval has over 70 years experience in solving problems of separation and clarification. Your problem may be quite similar to one that has already been solved by De Laval centrifugals. It will pay you to ask.

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

DE LAVAL *for Speeding Production by* **CONTINUOUS** *Separation and Clarification*

IN ION EXCHANGE

it's 38 years experience that counts!

The ability to manufacture the exact ion exchange material best suited to your needs and to design and make the most efficient equipment for its use . . . *this ability is Permutit's alone!*

It's this follow-through from the planning stage to plant operation that has made Permutit the foremost name in ion exchange! Thousands of installations in hundreds of industries!

Today, many revolutionary new uses for ion exchange are being developed. For the most advanced information about these latest developments that can serve you, write to The Permutit Company, Dept. CE-5, 330 West 42nd Street, New York 18, N. Y., or to the Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

WATER CONDITIONING
ION EXCHANGERS
MATERIALS & EQUIPMENT

Permutit

Integrator

Varying flows are accurately totalized because the integrator is continuous

Indicator-Recorder-Integrator

The Republic flow integrator, being of the modified watt-hour type, totalizes continuously—not intermittently. It operates independently of the recorder and its accuracy is not dependent on or affected by any clock mechanism or mechanical action.

The Republic meter is, on this account, peculiarly fitted to follow all changes in flow rate and accurately measure highly fluctuating flows.

ALL TYPES OF FLUIDS

Republic electric type flow meters are available for measuring the flow of all types of liquids and gases. Meter bodies are built for metering fluids at line pressures up to 5,000 lb. per sq. in. and for all ranges of differential pressure. The reading instruments—indicator, recorder and integrator—are of the remote reading type and can be located any distance from the point of flow measurement.

ANY COMBINATION

While each Republic reading instrument is standard in design and construction each is especially calibrated for the particular flow measurement for which it is specified. Any reading instrument, indicator, recorder or integrator, may be obtained separately or in any combination desired, making possible the highest degree of flexibility in plant use.

SIMPLE IN OPERATION

The Republic electric meter is the only flow meter commercially manufactured which is strictly electric in its operation. All other types of so called electric meters use the motion of the mercury to move a float or produce a force which is then converted into an electrical value which is in turn transmitted to a receiving or reading instrument. In the Republic meter, the transmitted electrical value is determined directly by the mercury motion, thus eliminating one of the steps in the sequence, and simplifying the mechanism to that extent. There are no floats, levers, cams, rotating shafts or anything else to interfere with the unimpeded movement of the mercury, which has no work to perform, but merely fulfills the function of making contact.

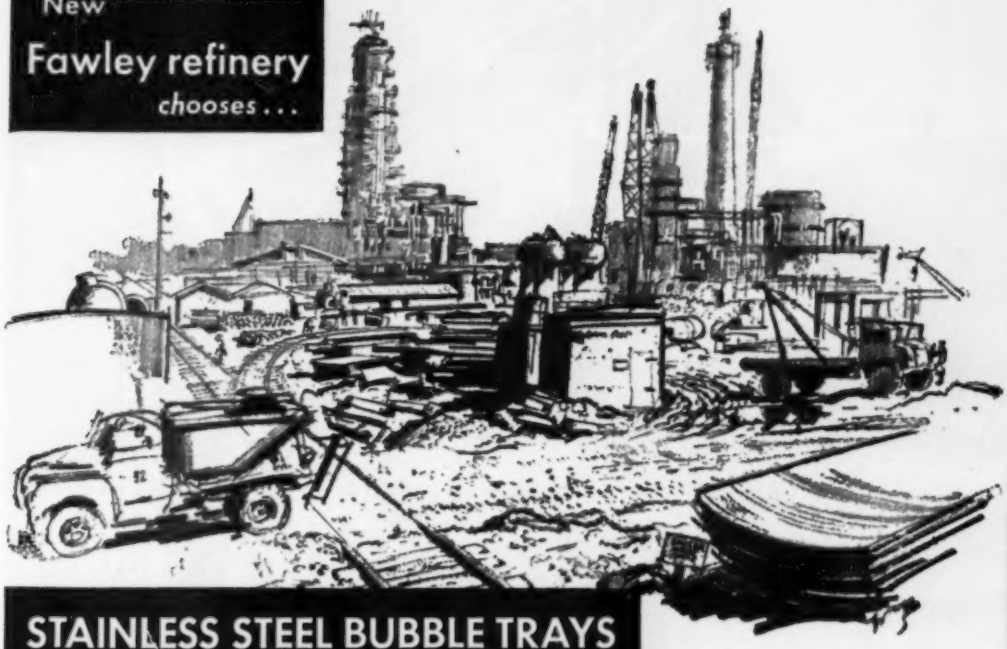
NEW DATA BOOK

Just off the press—a completely new data book describing and illustrating, in detail, the operating features of the Republic Flow Meter and its many applications. Write for your copy of Data Book No. 702—there is no obligation.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

New

Fawley refinery *chooses . . .*



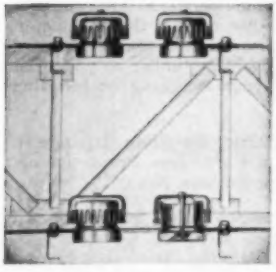
STAINLESS STEEL BUBBLE TRAYS

by Gilbarco

EUROPE'S LARGEST REFINERY—At Fawley, England, Gilbarco Bubble Trays will help make possible a daily crude oil processing capacity of more than 100,000 barrels.

GILBARCO'S new alloy BUBBLE TRAYS offer all these refinements for refining

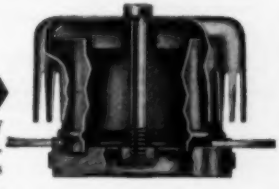
- **ADVANCED DESIGN**—Greater resistance to loading deflection. Increased accessibility to all tray levels. Greatly reduced joint leakage, minimum packing.
- **EASILY CLEANED**—Flush chimney mounting holes. One-man top-side removal of bubble caps. The inherent resistance to adhesion of smooth alloy metals.



"DUO-LEVEL" TRUSSES and IMPROVED BUBBLE CAPS

TWO TRAYS are supported by a common truss in the longer spans—means greater rigidity with lighter weight. Access for cleaning, inspection, or replacement is far easier.

BUBBLE CAPS—new design permits quick, easy removal by one man working from top side. There are no flanges or projecting edges around holes to slow up cleaning operations.

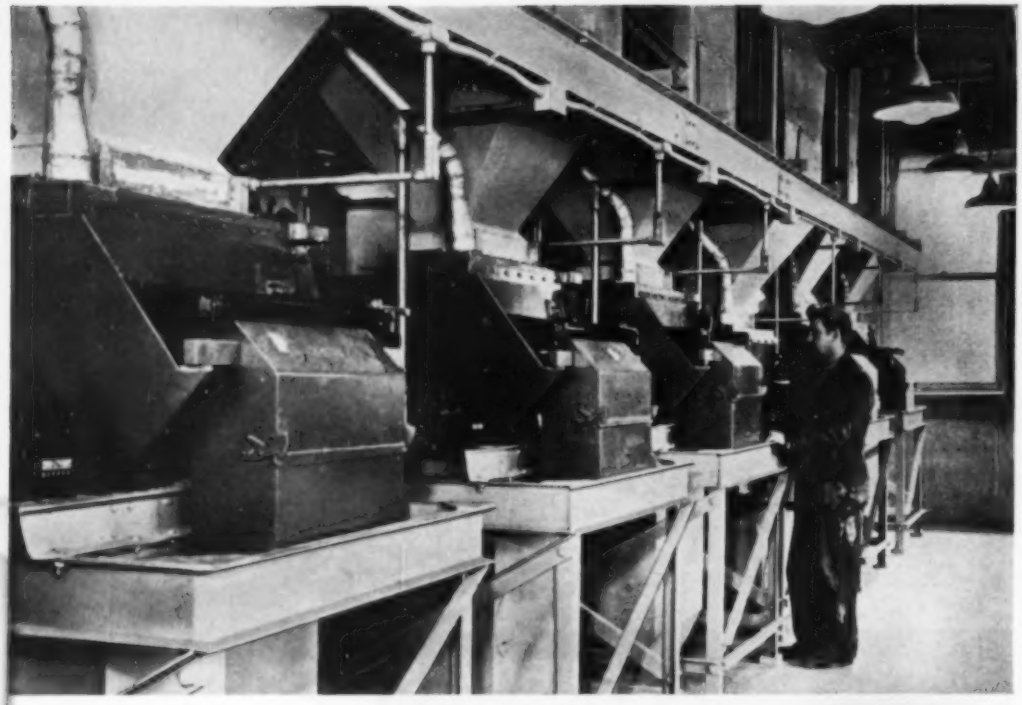


AVAILABLE IN ALL LIGHTWEIGHT METALS—Gilbarco with its large staff of experienced engineers stands ready to fulfill the needs of your process design.

Gilbarco

GILBERT & BARKER MFG. CO.

West Springfield, Mass.—Toronto, Canada
Established in 1865



RICHARDSON AUTOMATIC SCALES WORK FOR NABISCO

A high hourly volume of flour—accurately blended to meet the exacting requirements of National Biscuit Company's huge baking operations—those were the specifications, and Richardson supplied the foundation for success—perfectly blended wheat. A battery of Richardson Automatic Scales accurately keep pace with the speed and volume of Nabisco's tremendous operation.

PROBLEM:

To obtain the greatest possible consistency and accuracy in blending wheat on a high tonnage basis.

SOLUTION:

Installation of a battery of Richardson Automatic Scales—accurate to 1/10 of 1% of all material weighed. Accurate blending of wheat by weight was accomplished for the largest soft wheat milling operation in this country.

Perhaps you have a blending or weighing operation. Are results as accurate and efficient as you would like? Why not call on the backlog of experience of a Richardson engineer. At some time in Richardson's 50 years' experience in materials-handling-by-weight, a problem similar to yours has been met—and effectively solved. A survey of your weighing or blending problem places you under no obligation.

For information on Richardson Automatic Weighing Equipment, ask for Bulletin No. 0450. For information on Richardson Proportioning, Blending, and Process Control Equipment, ask for Bulletin No. 0550.

Richardson Scale Co., Clifton, New Jersey. Feeder-Weigher Systems of All Types: Automatic Bulk Weighing Hopper Scales, Including Conveyor-Feed Types—Continuous Feeder-Weighers—Automatic Bagging Scales—Bag-Sewing Conveyors—Packers—Process Control Panels. *Branch offices in:* Atlanta • Boston Detroit • Minneapolis • Cincinnati • Wichita • Montreal • Omaha • New York Pittsburgh • San Francisco • Toronto • Buffalo • Chicago • Philadelphia • & Houston.

Richardson

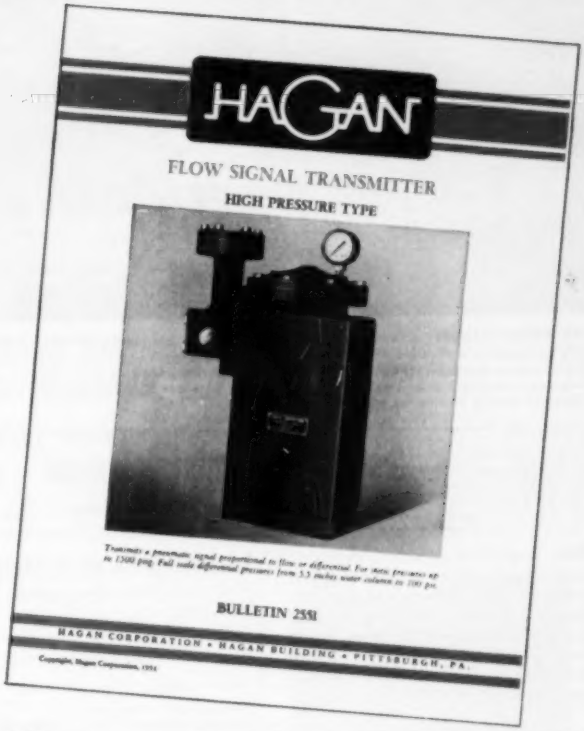
MATERIALS HANDLING BY WEIGHT SINCE 1902

7631

HAGAN

Flow Signal Transmitter

. . . measures pressure or flow and transmits a proportionate signal to remotely-located recording or control devices.



for detailed information

Send for this bulletin

Just fill out and mail the coupon

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

Hagan Corporation
Hagan Building, Pittsburgh 30, Pa.

Please send me a copy of your new bulletin, "Hagan Flow Signal Transmitter."

NAME.....

POSITION.....

COMPANY.....

STREET & NUMBER.....

CITY..... STATE.....

CE-5

MONSANTO
CHEMICALS—PLASTICS

THE WORLD'S LARGEST elemental phosphorus plant, the Monsanto plant at Monsanto, Tennessee, now is expanding production. The largest phosphorus furnace in the world soon will be completed. The Monsanto plant, located on the Tennessee beds of rich phosphate rock, already has five furnaces in operation producing elemental phosphorus of better than 99.9% purity from which Monsanto quality phosphates are derived.

Research Chemists' Corner

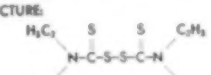
You may find something new here

With these three Monsanto chemicals, your research may reveal ways to improve products, create new materials or replace hard-to-get ingredients. If specifications given here suggest such possibilities, send for samples for experimentation. Samples will be sent to qualified persons without cost or obligation.

Tetraethylthiuram disulfide

—Bis (diethylthiocarbamyl) disulfide

STRUCTURE:



APPEARANCE: Light-gray to white powder.
SPECIFIC GRAVITY: 1.30 at 25° C.
MELTING POINT: 67° C. min.
SOLUBILITY: Soluble in acetone, benzene and naphtha.
ASH: 0.5% max.

SEND FOR BOOKLET — "30 Special Monsanto Chemicals" will be sent to you free upon request. Indicate your wishes on the coupon.

Tetramethylthiuram disulfide

—Bis (dimethylthiocarbamyl) disulfide

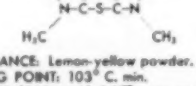
STRUCTURE:

APPEARANCE: White powder
SPECIFIC GRAVITY: 1.29 at 25° C.
MELTING POINT: 146° C. min.
FINENESS: (200-mesh) 0.5% max. retained.
SOLUBILITY: Soluble in acetone and benzene.
ASH: 0.5% max.

Tetramethylthiuram monosulfide

—Bis (dimethylthiocarbamyl) sulfide

STRUCTURE:



APPEARANCE: Lemon-yellow powder.
MELTING POINT: 103° C. min.
FINENESS: (200-mesh) 1.0% max. retained.
SOLUBILITY: Slightly soluble in benzene, acetone and carbon tetrachloride.
MOISTURE: 0.5% max.
ASH: 0.5% max.

Santomerse No. 1 a versatile detergent and wetting agent

There's a good reason why Monsanto Santomerse* No. 1 is called the all-purpose detergent and wetting agent. The reason: *versatility.*

Santomerse No. 1 is used effectively for cleaning, penetration, dispersion, emulsification and spreading. With such versatility, all-purpose Santomerse No. 1 is adding to efficiency in numerous operations in industry.

Anionic Santomerse No. 1 has a minimum of 40%-active alkyl aryl sulfonate, the remainder being principally sodium sulfate builder. This is the combination found best for high efficiency and economy.

Santomerse No. 1 is effective in hard or soft water, in acid or alkaline baths, in hot or cold solutions. In operations where the pH is important, Santomerse No. 1 can be used because it does not affect the pH to any marked degree.

If you use a detergent and wetting agent in your industrial processes, look into the possibilities Santomerse No. 1 offers. Write for a copy of Monsanto's booklet, "*Santomerse No. 1 All-purpose wetting agent and detergent,*" which gives much useful technical information.

Sterox SE, SK, No. 5, and No. 6 rapid-acting wetting agents

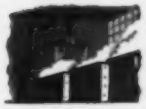
If you have an operation that calls for wetting out, spreading, penetrating, scouring or emulsifying, look into the possibilities of the Monsanto Steroxes.

Sterox* SE and SK are 100%-active nonionic detergents which offer high sudsing and controlled dusting. Sterox 5 and 6 are like SE and SK, respectively, except that they are 85% active. All are liquids and all readily soluble in water at room temperature.

For complete details, mail the coupon for Technical Bulletin No. P-133 (on SE and SK) and Technical Bulletin No. P-136 (on No. 5 and No. 6).

These uses may suggest ways you can employ Santomerse No. 1

The uses for Santomerse No. 1 are so numerous that it is next to impossible to name them. Here are a few applications for the all-purpose detergent and wetting agent which may suggest other uses to you.



Metal Industry
Santomerse No. 1 in the acid bath for cleaning, treating or pickling metal improves operations and the quality of the work.

Railroad Car Cleaners
Santomerse No. 1 improves the detergency of acid-type cleaning compounds to remove scale and road grime.

Household Cleaners
Santomerse No. 1 formulations make excellent cleaners for home laundering, dishwashing, floor and woodwork cleaning and in numerous other cleaning jobs.

Dehairing Hogs
Santomerse No. 1 in the scalding vat speeds up the removal of hair and scurf.

Dairy Cleaners
Santomerse No. 1 adds to the efficiency of acid, neutral and alkaline dairy cleaners.

Agricultural Sprays
Used as a wetting and dispersing agent, Santomerse No. 1 increases the effectiveness of the spray.

Unload 'em quickly and send 'em home

If you buy chemicals in carboys, drums or tank cars, empty the containers as soon as you can and send 'em home. We suggest this whether they're Monsanto containers or not. The sooner your supplier gets back his containers, the sooner he can fill 'em and ship 'em to give you better service.

AROCLORS improve quality... economically ...in numerous paints and plastics

Many paints and numerous plastics gain extra qualities when Monsanto AROCLORS are incorporated into their formulas. And, since the AROCLOR * probably costs less than an ingredient it replaces, production costs are lowered.

The AROCLORS (chlorinated biphenyl and chlorinated polyphenyls) are used in modified and synthetic rubber coatings, lacquers, hot-melt strip coatings, vinyl protective coatings, maintenance paints, adhesives, fire-resistant paints and marine paints. With AROCLORS, the coatings gain in gloss, toughness, nonflammability and resistance to water, acids, alkali and other corrosive influences. Paints made with AROCLORS have excellent adhesion.

Various AROCLORS are employed in the plastics industry as coplasticizers with more expensive plasticizers.

There is a series of AROCLORS, both liquids and resins, from which you can choose exactly the properties you want. For details, mail the coupon or contact the nearest Monsanto Sales Office.

Monsanto Isocyanates offer possibilities in product development

Monsanto was the first American company to produce isocyanates, a group of German-developed industrial products which have many unexplored possibilities.

Already the products are being used in adhesives, paints, rubber, plastics and textiles. They are employed in the fields of high polymers, copolymers and terpolymers, and may have possibilities in medicinals, insecticides and other compounds.

At present, Monsanto is producing ethyl isocyanate, phenyl isocyanate, octadecyl isocyanate and p,p' Diisocyanato-diphenyl methane.

If interested in the isocyanates, mail the coupon for a copy of Monsanto Technical Bulletin No. P-125. It's highly technical.

AN AROCLOR was used in compounding this Thermo-Dip plastic coat which is used to protect the metal gear from rust.

HB-40 used as extender for primary plasticizers

Monsanto HB-40 (partially hydrogenated terphenyl) is used as an extender for primary plasticizers in vinyls. As much as 25% to 50% of HB-40, on the total weight of the plasticizer, may be used. HB-40, being practically water-white, can be used in properly stabilized clear and tinted vinyl plastics. It is a low-cost plasticizer for styrene plastic dispersions and casting resins. Mail the coupon for details.

• • • • • • • •

MONSANTO CHEMICAL COMPANY, 1702-E South Second Street, St. Louis 4, Missouri. District Sales Offices: Birmingham, Boston, Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Los Angeles, New York, Philadelphia, Portland, Ore., San Francisco, Seattle. In Canada, Monsanto (Canada) Ltd., Montreal.

*Reg. U.S. Pat. Off.

MONSANTO
CHEMICALS—PLASTICS

SERVING INDUSTRY... WHICH SERVES MANKIND

SEND INFORMATION: ☐ Santomerse No. 1. ☐ AROCLORS. ☐ Isocyanates. ☐ HB-40.

SEND LITERATURE: ☐ Booklet, "30 Special Monsanto Chemicals." ☐ Bulletin, No. P-125. ☐ Bulletin No. P-133. ☐ Bulletin No. P-136. ☐ Booklet, "Santomerse No. 1 All-purpose wetting agent and detergent."

SEND SAMPLES: ☐ Tetraethylthiuram disulfide. ☐ Tetramethylthiuram disulfide. ☐ Tetramethylthiuram monosulfide.

MONSANTO CHEMICAL COMPANY
1702-E South Second Street, St. Louis 4, Missouri

Please send, without cost or obligation, information, literature or samples as indicated at the left.

Name.....Title.....

Company.....

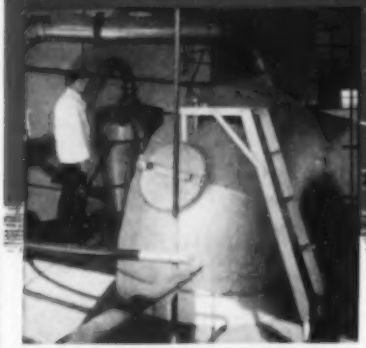
Street.....

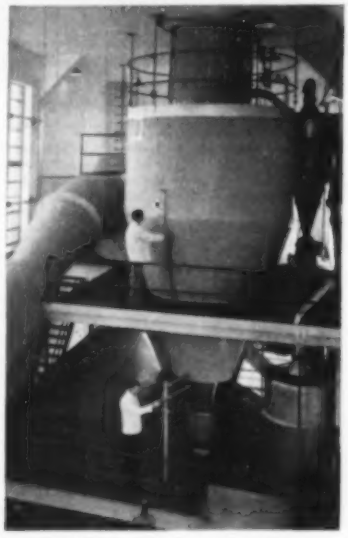
City.....Zone....State.....

Is your material like one of these?

Alfalfa extract
Aluminum sulfate
Ammonium chloride
Animal blood
Azo dye pigments
Basic chrome sulfate
Bone glue
Calcium acetate
Caramel coloring
Cascara extract
DDT dusting powders
Detergents
Distillers' solubles
Lignin
Lime & Sulfur
Manganese sulfate
Molasses fermentation residuum
Organic dyestuffs
Pectin
Penicillin waste liquor
Pentaerythritol
Photographic chemicals
Polymethacrylic acid
Polyvinyl chloride polymers
Potassium acetate
Proteinaceous extracts
Sodium phosphates, mono-, di-, tri-
Sodium sulfate
Soya bean extract
Specialty starches
Starch conversion products
Sulfite liquor
Tannin extract
Toxaphene dusting powder
Yeast culture
Zinc sulfate monohydrate

A few of the many materials that are now successfully spray dried





Above photos were taken inside the Swenson Spray Dryer Laboratory

—then probably you can profit by

SPRAY DRYING

By test-drying a typical sample in the Swenson Spray Dryer Laboratory, it can quickly be determined whether or not your material is susceptible to spray drying. Such tests may be arranged at reasonable cost.

As the result of data secured during such test runs, our engineers determine the most efficient, economical design for building production equipment.

Swenson Spray Dryers are now at work on a wide variety of materials, many of which were unknown just a few years ago. If you are working with a new material, do not overlook the economies of spray drying in your process. Swenson engineers are glad to offer every possible co-operation.

SWENSON EVAPORATOR CO.
DIVISION OF WHITING CORPORATION
15669 Lathrop Avenue Harvey, Illinois
Eastern Sales Office and Export Department: 30 Church Street, New York 7, N. Y.
In Canada: Whiting Corporation (Canada) Ltd., 47-49 LaPlante Ave., Toronto 2

The Inside Story of Longer-Lasting Laboratory Electric Furnaces . . .

CORES, MUFFLES AND TUBES stand up longer in most electric furnaces when they're made of highly stable, chemically inert Norton Alundum* refractory mixtures capable of resisting temperatures up to 1850° C in either oxidizing or reducing atmospheres.

...FEATURING NORTON ALUNDUM REFRACTORIES*

Whether your laboratory furnaces are of the pot, muffle or tube variety, for chemical analysis, physical testing or metallurgical research, they will function more efficiently and last much longer when built with Norton Alundum cores, muffles or tubes.

4 REASONS WHY

1. Norton Alundum electric furnace parts are made from fused aluminum oxide that is 99% Al_2O_3.

2. *Such purity results in a high degree of stability and chemical inertness* that prevents reactions with either resistor materials or platinum, nickel, and fused oxide crucibles and boats at high temperatures.

3. *Norton Alundum furnace shapes are excellent thermal conductors*, thus assuring small temperature gradient between the resistor and the furnace interior.

4. *Norton Alundum refractory is a good electrical insulator up to relatively high temperatures.* One test on an Alundum tube shows a direct current resistance of 7.5 x 10^7 ohms/cm^3 at 600° C. This value did not fall off materially until a temperature in excess of 1000° C was reached.

WHAT ABOUT SILICON CARBIDE?

Norton Crystolon* refractory muffles, made of bonded silicon carbide, have a thermal conductivity several times that of Alundum refractory. However, at high temperatures, Crystolon refractory not only is an electrical conductor but also reacts chemically with some resistors. For these reasons, its use is limited to nickel chromium alloy resistor materials and to temperatures not exceeding 1150° C.

FOR THE WHOLE STORY about Norton Alundum refractories' vital part in improving laboratory electric furnaces, write for FORM 438, titled, "The Construction of Electric Furnaces for the Laboratory."

NORTON COMPANY
505 New Bond St., Worcester 6, Mass.

NEW 24-PAGE BULLETIN tells you all you need to know about building electric furnaces for laboratory use.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

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Making better products to make other products better

Special REFRACTORIES

Canadian Representative
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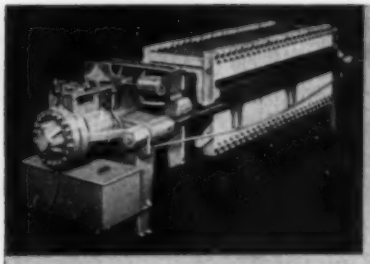
25 GOOD REASONS

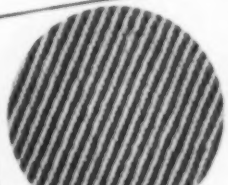


WHY INDUSTRY DEPENDS ON SPERRY FOR FILTRATION

The plate filter press, the filtration method pioneered by Sperry is the most widely used filter in industry today. The inherent advantages of this type of filter explain its wide usage.

Consider these advantages as applied to your own operation. Compare the flexibility, low first cost, low operating cost of a Sperry Filter Press with any other type of filter on the market.

For more specific data as to your own filtration problem consult Sperry. Send samples of your material for a test run.



SPERRY FILTER BASES

Sperry offers a full range of filter bases. All types and sizes. Plain or punched to your specifications. In addition to cotton and paper, bases are furnished in wool, synthetics, glass and woven metals. Consult Sperry for special bases to meet unusual requirements.

THE SPERRY FILTER PRESS:

1. Will handle any kind of filterable mixture, including viscous substances.
2. Produces maximum clarity.
3. Produces the driest cake.
4. Can deliver cake in slab form suitable to place in drier trays.
5. Thoroughly washes the cake.
6. Uses the simplest kind of filter cloths. (Can use cloth cut direct from roll.)
7. Cloths are easily removed and replaced.
8. Can use filter paper or pulp.
9. Can be used with precise temperature control.
10. Can handle hot liquors without vaporizing.
11. Is easily made of acid or alkali resistant material.
12. Low first cost.
13. Low cost of labor.
14. Least floor space and head room required.
15. Weight per square foot no greater than other types.
16. Low depreciation.
17. Can perform low, medium, or high pressure filtration.
18. Easily resold. (On account of its wide use.)
19. Can filter without exposing the liquid to the atmosphere.
20. Can be used to separate emulsions.
21. Easily erected by unskilled labor.
22. Can be transported in small pieces.
23. Will deliver filtrate to higher level than filter.
24. Can use wire, wool, asbestos, glass, vinyon, and many other kinds of filter cloths.
25. Can be furnished in leak-proof construction.

D. R. SPERRY & COMPANY

BATAVIA, ILLINOIS

Filtration Engineers for over 50 years

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205 E. 42nd St., New York 17, N. Y.; Phone MUrray Hill 4-3581

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833 Merchants Exchange Bldg., San Francisco 4, Calif.
Phone DO 2-0375

SPERRY FILTER PRESSES

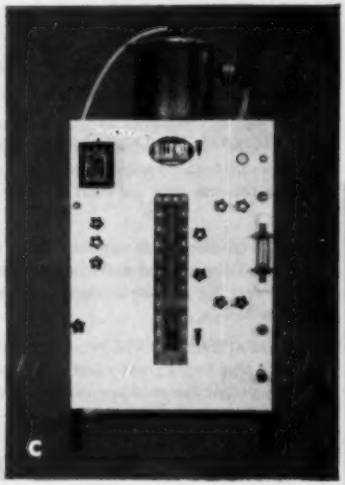
ILLCO-WAY offers a complete line of

"Packaged" DE-IONIZERS

Requirements for pure water in many plants are served by these famous "packaged" units, which are shipped completely assembled and mounted on a welded-steel base. They require only connection to raw water, drain and treated-water outlets. Typical ILLCO-WAY De-ionizers are models shown below.

A

B


C

A Industrial De-ionizer, one of a series providing solids-free water comparable to single-distilled water. Flow rates up to 1,000 gph. Shipped completely assembled with full accessories for operation, including purity indicator. Units can be furnished with materials for silica and CO_2 removal. Floor space: approximately 5' x 3'. Height: approximately 7 ft.

B Popular Portable De-ionizer provides solids-free water comparable to single-distilled water. Flow rates up to 20 gph. Capacity: 200 gallons on water containing 10 grains of dissolved solids. This versatile model can be furnished with materials for silica and CO_2 removal. Like the other ILLCO-WAY units shown, this portable De-ionizer is designed to be "regenerated" when the treated water becomes impure, thus avoiding the expense of throw-away cartridges.

C Industrial Mixed-Bed De-ionizer* provides treated water, with specific resistances up to 15,000,000 ohms. Shipped completely assembled, ready for operation, with full accessories including purity indicator. Flow rates up to 1000 gph. Floor space: 25" x 40" (max.). Height: approximately 7 ft.

D Portable Mixed-Bed De-ionizer* provides treated water with specific resistances up to 15,000,000 ohms. These units, with flow rates up to 30 gph, are specifically designed for use in laboratories or wherever small quantities of high purity water are required.

E Industrial installation (300 gpm). Such units are individually designed to provide any flow, any volume.

* Patent pending

See data in Sweet's File, Engineering

ILLCO-WAY

DE-IONIZING
DE-ALKALIZING
SOFTENING

ILLINOIS WATER TREATMENT CO., 844-5 Cedar St., Rockford, Illinois • 141 East 44th Street, New York City

Canadian Distributor: Pumps & Softeners Ltd., London, Ontario

New Boiler Code Rulings permit Higher Temperatures with INCO Nickel Alloys

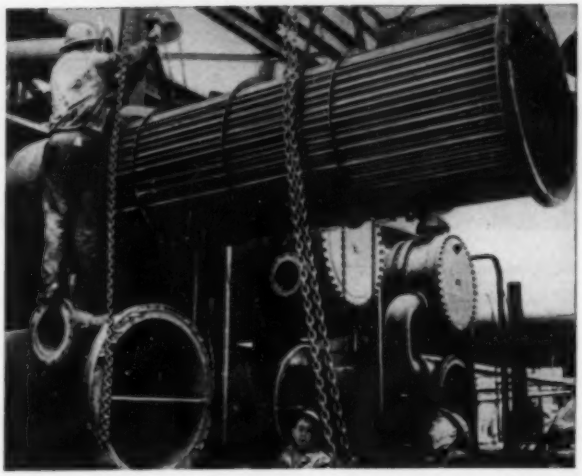
New interpretations of the A.S.M.E. Boiler Code have raised temperature limits on INCO Nickel Alloys used in the construction of unfired pressure vessels.

Also, in addition to annealed Monel, it is now permissible to use stress-relieved Monel, which has substantially higher mechanical properties.

These two modifications of the code mean that it is now possible to build stronger and lighter heat exchangers for higher temperature service, *that are insurable because they are built to code requirements.*

But this modified code applies only to physical properties. To overcome corrosion troubles, users must assume the responsibility for choosing the correct materials.

A glance at the table will show how some users have been able to get greatly increased equipment life by the proper choice of heat exchanger metals...



A cleaned exchanger tube bundle being replaced in its shell. "Spring-cleaning" like this prevents failures in service and insures efficient heat exchange. *Photo courtesy The M. W. Kellogg Co., New York, N. Y.*

To see if INCO'S Corrosion Engineering Service can help you, write, outlining your problem.

And at the same time, ask for a free copy of the new "Boiler Code Interpretations Involving Nickel, Monel, Inconel." It lists the new stress and temperature limits for the INCO Nickel Alloys.

OPERATING HISTORIES OF MONEL HEAT EXCHANGER TUBING

Case No.	Products Handled		Highest Temperature	Service Life		
	Inside tubes	Outside tubes		Previous Material	Monel tubes	Condition of Monel at last inspection
1	Steam	Caustic	350	2-8 weeks	17 months	Good—still in service
2	Foul Caustic	Steam	300	5 months	25 months	No evidence of corrosion
3	Heavy recycle	Straight run gasoline distillate	550	6665 hours	38,535 hours	Renewed 24 tubes after 22,000 hours—3 tubes plugged at 38,535 hours. Remainder OK.
4	Caustic soda and sodium chloride	Steam	240	10 months	80 months	Good—15 tubes replaced—weld failures
5	Crude oil	Gasoline vapor	300	6-8 months	48-60 months	No inspection

Service information on heat exchangers closely similar to yours is probably not in this table. However, help is available from INCO'S Corrosion Engineering Service. From their thousands of data sheets showing corrosion rates in a wide variety of media, it is likely that an answer to your specific problem can be found.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

EMBLEM OF SERVICE
NICKEL INCO ALLOYS

Monel® • "R"® Monel
"K"® Monel • "KR"® Monel • "S"® Monel
Nickel • Low Carbon Nickel • Duronickel®
Inconel® • Inconel "X"®

A Headline that is also a Helpline!

1 BUFLOVAK OFFERS PROFITABLE COOPERATIVE ASSISTANCE

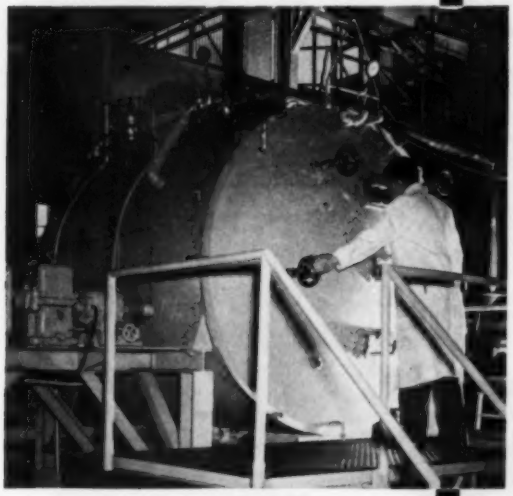
2 IN ITS RESEARCH AND TESTING LABORATORIES

3 . . . A PRE-TESTING SYSTEM THAT HAS SOLVED 6500 PROCESSING PROBLEMS

4 IN THE CHEMICAL, FOOD AND PHARMACEUTICAL FIELDS

●

Low-temperature drying for heat-sensitive products is performed on this sanitary type Stainless Steel Vacuum Double Drum Dryer installed in the BUFLOVAK Laboratory.



1 BUFLOVAK Research Laboratories and Testing Plant are maintained for your use . . . to help you solve problems in drying, evaporation, extraction, solvent recovery, crystallization, and food processing.

2 Completely equipped with pilot plant equipment for low-temperature evaporation and drying, and other advanced processes that lead to improved operations.

3 Here tests can be completed, ranging from a few beakers of precious material to tank-car quantities requiring round-the-clock operation on a production scale. Results are definite! Production data is accurate! BUFLOVAK'S pre-testing has given the right answer to more than 6500 processing problems!

4 Many new methods, highly profitable to their users, have been developed for use in the Chemical, Food and Pharmaceutical fields.

Your investment in BUFLOVAK equipment can be safeguarded by pre-testing your product to prove at the start whether you are on the right track to profits.

Write for complete information.

BUFLOVAK BUILDS

EVAPORATORS
Low-Temperature
By-Product Recovery
Chemicals
Food Product
Crystallization

DRYERS
Vacuum Double Drum
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PROCESSING KETTLES
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Distillation Equipment

SEND FOR CATALOGS

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DIVISION OF BLAW-KNOX CO.
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Give your Republic Distributor half a chance and he'll lick your toughest problem in the application of industrial rubber products. Call him today for a free analysis!

TEXAS PEANUT COMPANY SAYS IT PAYS TO..

Try Republic First

Texas oil doesn't all come from wells. Folks down thataway raise more than 300 million pounds of peanuts every year and there's a lot of oil in peanuts. So much, in fact, that ordinary conveyor belts can't even haul *unshelled* peanuts without serious damage. The belt covers swell up . . . become sticky masses of gum that leave the carcass completely unprotected from abrasion and mildew.

Republic Rubber Conveyor Belting, made of oil-resisting Reprene, is the answer. Since switching to Republic, the Texas Peanut Company, Commanche, Texas, has had two seasons of uninterrupted service from their conveyor belt, which they say, " . . . shows absolutely no signs of wear!"

If your work has anything to do with oil contact of any kind, we suggest you quickly get in touch with Republic or your Republic Distributor. He sells a complete line of oil-resisting hose, conveyor belt, transmission belt . . . *everything in industrial rubber products* and, believe us, it pays to try Republic First!

INDUSTRIAL RUBBER PRODUCTS BY

REPUBLIC RUBBER DIVISION

Lee Rubber & Tire Corporation

YOUNGSTOWN, OHIO

CONVEYOR BELT MAINTENANCE TIP
Your conveyor belt will give longer service when the load is equalized across its width. Keep your belt running straight and maintain uniform loading.

WATER OF ANY DESIRED QUALITY FROM ANY RAW WATER SUPPLY

Perhaps your process demands highest quality, essentially ion-free water from normal water supplies. Perhaps you must prepare only relatively pure water from very hard or brackish water.

Either way, the right combination of AMBERLITE Ion Exchange Resins gives you *the water you want from the water you've got!*

For example—From the strongly basic anion exchangers AMBERLITE IRA-400 and IRA-410, and the strongly acidic cation exchanger AMBERLITE IR-120, you can obtain water of 5,000,000-20,000,000 ohms/cm. resistance (less than 0.1 p.p.m. *total* ionized solids).

With the weakly basic anion exchanger AMBERLITE IR-45 and the strongly acidic cation exchanger AMBERLITE IR-120, metallic cations and mineral acidity can be eliminated, leaving in solution only weakly acidic materials such as silica and CO_2. Electrical resistance is in the neighborhood of 300,000 ohms/cm. (less than 1 p.p.m.).

By means of the weakly basic anion exchangers, AMBERLITE IR-45 and IR-4B, and the weakly acidic cation exchanger AMBERLITE IRC-50, marked reduction of total ionized solids can be accomplished economically, without complete deionization.

MONOBED — *Newest word in Ion Exchange*

A method of intermixing acidic and basic resins in a single unit. With Monobed, deionized water can be obtained in one pass through one column. Ask for booklet AMBERLITE MONOBED DEIONIZATION.

Want to know more about the uses of AMBERLITE Ion Exchange Resins? Write Department CI-1 today for full technical data.

CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION

Washington Square Philadelphia 5, Pa.

Representatives in principal foreign countries

AMBERLITE *is a trade-mark, Reg. U. S. Pat. Off. and in principal foreign countries*

Built FOR better LIVING

That is what the carefully patterned mazes of refinery equipment, produced by Sun for many leading refineries, mean for America.

These towering refineries mean light, heat, comfort and power for the nation's homes and industries . . . fuel for transportation by ship, rail and motor car . . . mobility for our naval and military forces.

They must not fail . . . *they will not fail!* Into their making have gone Sun's engineering skill and craftsmanship, time-tested in wide fields of mechanical production . . . in refinery and chemical plant equipment, in shipbuilding, in fabricated steel work, in the renowned and powerful Sun-Doxford marine Diesel engines and other specialized machinery.

The more exacting the specification, the greater opportunity for Sun to maintain its engineering prestige.

Sun

SHIPBUILDING & DRY DOCK COMPANY

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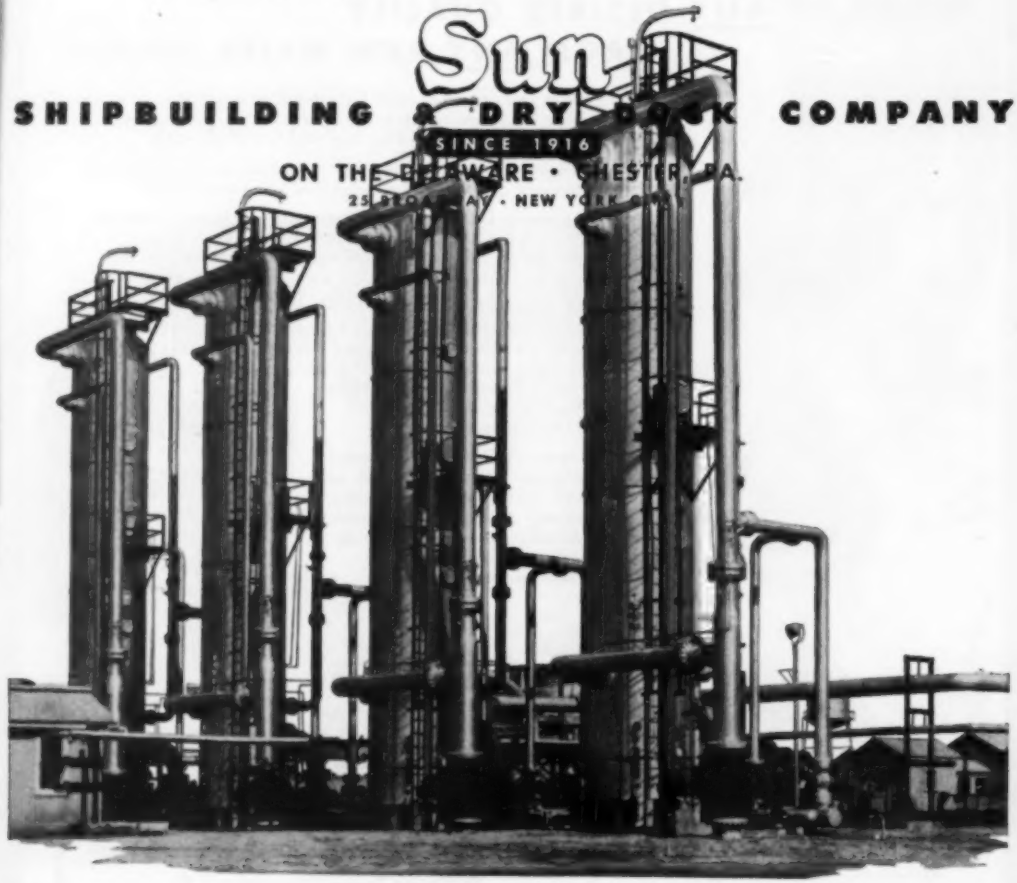

THE VALVE THAT WAS DESIGNED FOR

PETROLEUM CHEMICAL SERVICE

THE

Cameron

NON-LUBRICATED

LIFT-PLUG VALVE

Originally designed for acid and light hydrocarbon service and first tested and proved in one of the nation's largest wartime alkylation units, the Cameron valve has since distinguished itself in all sorts of difficult petrochemical services — chlorine, caustic, ammonia, gas distillate, ethylene oxide, butane, propane, molten sodium, oilfield and others.

The Cameron Non-Lubricated Lift Plug Valve combines the best features of gate and plug valves with a number of new mechanical innovations. Test it in your most difficult service. See for yourself how easily it operates and how tightly it seals, yet it requires no lubrication. Consequently the possibility of product contamination and clogging of metering equipment is eliminated. No periodic maintenance. No lubrication expense.

A descriptive booklet will gladly be sent to interested operators on request.

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Represented in the sterling area by: British Oilfield Equipment Co., Ltd., Duke's Court, 32 Duke Street, London, S. W. 1.

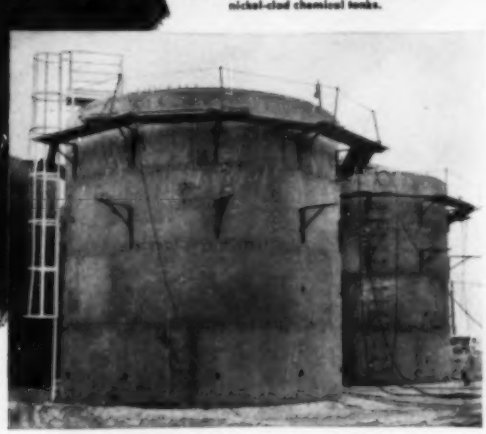
Another example of GRAVER *skill!*

Graver welders at work on field erection of nickel-clad chemical tanks.

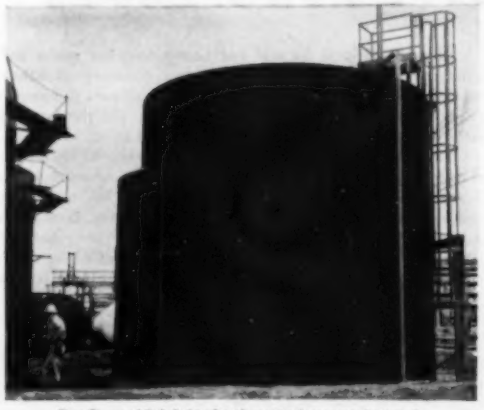
GRAVER

FIELD ERECTION IN ALLOYS

Field erection of special steels, stainless, alloys, clads and aluminum requires special techniques and specially trained crews. Graver is one of the few fabricators who can offer the surety of successful, long-lasting construction of alloy vessels and tanks. Graver's experience in this work is as old as the use of alloys. As an example, photographs are shown of a recent site-erection of two nickel-clad tanks for a large chemical company. This job is significant because it is a repeat order duplicating a previous pair of nickel-clad tanks of the same size for the same purchaser.



Exterior view of two butt-welded, nickel-clad storage tanks. Capacity: 2,100 bbls. each. Size: 25' O.D. x 34'.



Two Graver nickel-clad tanks adjacent to those recently erected. Same capacities and dimensions as new tanks above.

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

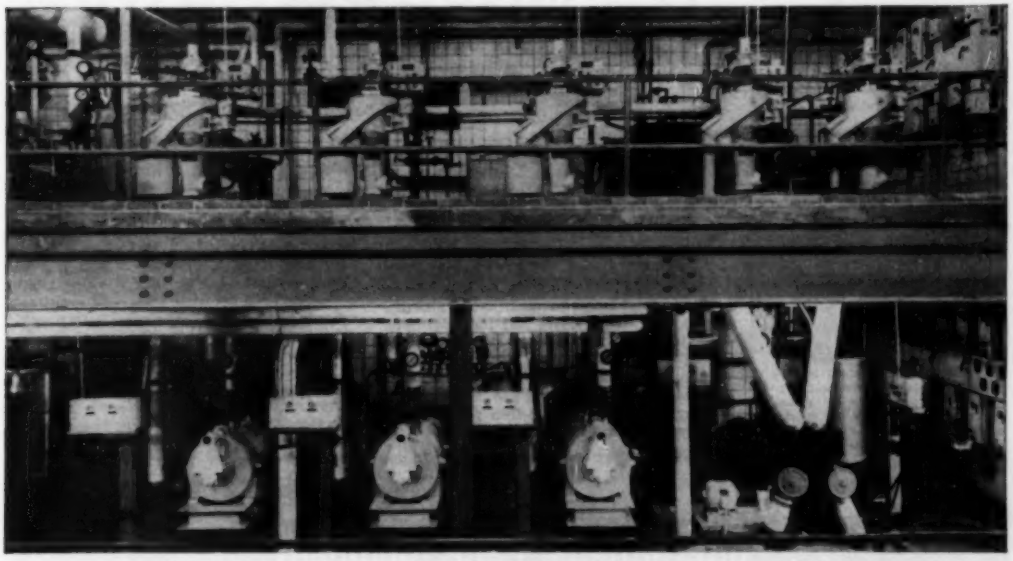
NEW YORK • CHICAGO • PHILADELPHIA • WASHINGTON
DETROIT • CINCINNATI • CATASAUQUA, PA.
HOUSTON • SAND SPRINGS, OKLA.

EVERY STEP OF THE WAY

A continuous soap plant . . . a system for converting Bunker C oil to an economical diesel fuel . . . a process for recovery of naphthalene as a coke oven by-product . . . a continuous vegetable oil refining plant . . . a process for recovering oil and meal from animal tankwater waste . . . a tar dehydration system . . . a process for production of condensed fish solubles . . . a method for purifying pipe line crude oil for use as a diesel fuel . . . these are a few of the dozens or more centrifugal processes and applications which The Sharples Corporation engineers all the way . . . from drawing board and process design through installation, to on-the-job training of operators, and guaranteed satisfactory plant operation.

The success of Sharples process engineering lies in the fact that not only do we manufacture seven basic types of centrifuges—but we also have the process know-how of designing, integrating, and balancing the entire system of pumps, heaters, evaporators, condensers, tanks, instrumentation, controls, digesters, etc., which provide you with a satisfactory plant or process . . . operating to guaranteed performance . . . carried every step of the way with one undivided responsibility in the capable hands of The Sharples Corporation.

If you are contemplating plant expansion, or a change in your present method of processing, don't hesitate to bring your thoughts to us. We'll gladly discuss them with you.



Sharples Continuous Soap Process installed in the plant of Dobbelman, Ltd., Nijmegen, Holland.

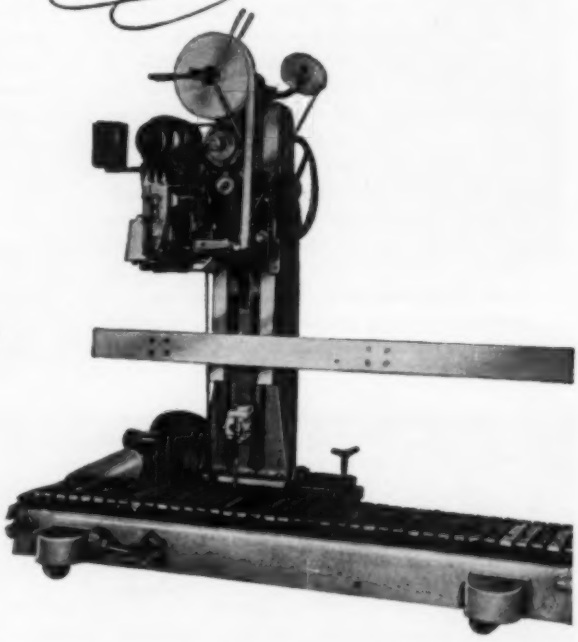
SHARPLES

THE SHARPLES CORPORATION • 2300 WESTMORELAND STREET, PHILADELPHIA 40, PENNA.

NEW YORK • BOSTON • PITTSBURGH • CLEVELAND • DETROIT • CHICAGO • NEW ORLEANS • SEATTLE • LOS ANGELES • SAN FRANCISCO • HOUSTON

THE BAG CLOSER WITH THE

"built-in Guardian Angel"



Model ET applies famous "Cushion-Stitch" over dry tape for sift-proof closure. Model E-1 applies "Cushion-Stitch" only, for use where sift-proofing is not essential.

When you buy a Bagpaker®, you get a "guardian angel" as well.

He may not look as angelic as the cherubs on a Christmas Card, but his intentions are just as golden. He's the Bagpak Service Engineer, and his job is to keep your Bagpaker in good shape—happy and well-adjusted so that it can provide the kind of continuous, trouble-free performance it was built to give.

That isn't very hard for a Bagpaker to do, because Bagpak designers have put in *extra strength*—heavy duty working parts—welded steel construction—all improvements that reduce lost time due to breakdowns. The savings on this alone can be tremendous over the years.

The combination of superior design and construction, plus experienced Bagpak service, makes the Bagpaker the kind of machine that brings your bag closing operation "a little closer to heaven."

For full details, write today and ask for booklet 255 E

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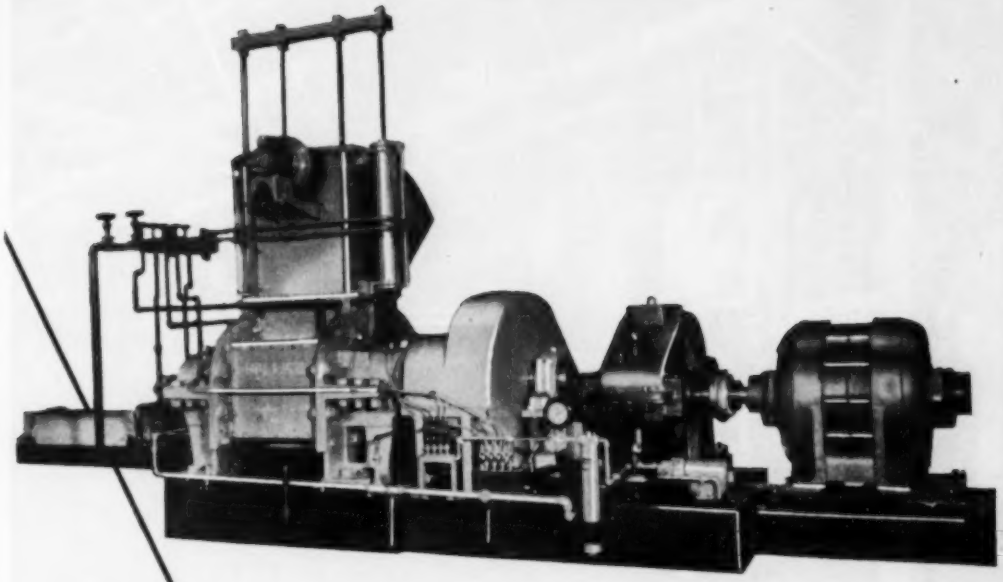


"INTENSIVE MIXER" FOR RUBBER AND PLASTICS

Stewart Bolling & Company, Inc., call their new No. 4 Intensive Mixer* "sensational." And it is outstanding on every count, embodying new concepts in mechanical construction. Used in mixing rubber and plastics, the No. 4 consumes less power while it mixes fast and insures good dispersion. SKF's were specified for the four main bearings in the split end frames—the two gear train bearings—and the four bearings in the reducer. Preferred by industry because of their inherent ability to minimize friction, their uniformly high quality maintained by constant vigilance, and their proved dependability in every type of service, SKF Bearings are making major contributions to faster production, lower maintenance, increased dependability in many types of chemical manufacturing equipment. 7252

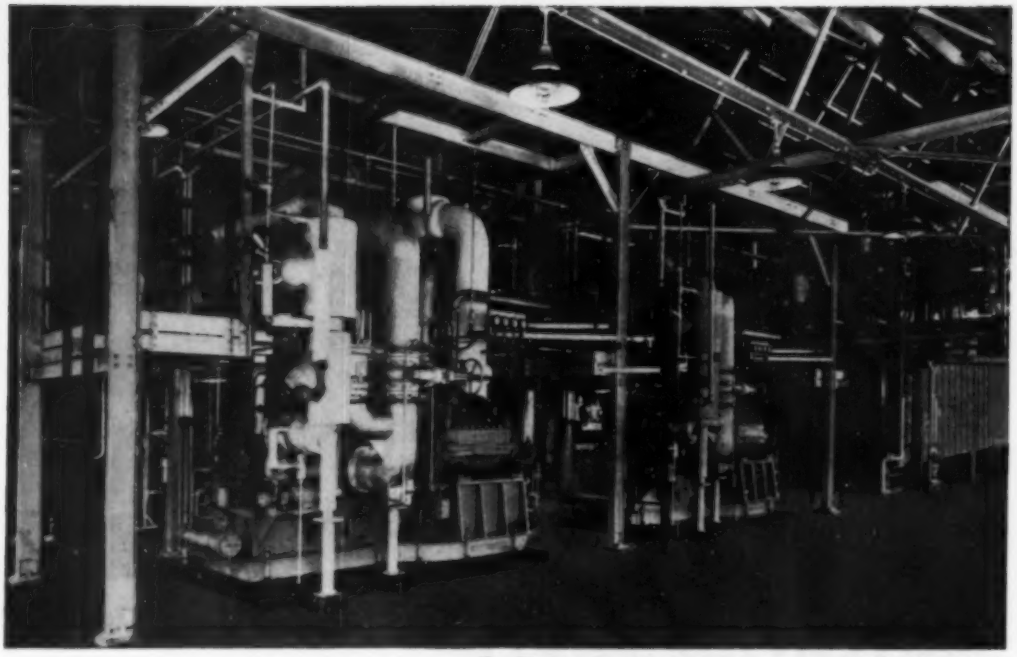
*For detailed information, write Stewart Bolling & Company, Inc., 3190 E. 65th St., Cleveland 4, Ohio.

8 REASONS WHY SKF IS PREFERRED BY ALL INDUSTRY

integrity
craftsmanship
metallurgy
tolerance control
surface finish
product uniformity
engineering service
field service

SKF
BALL AND ROLLER BEARINGS

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.
—*manufacturers of* SKF *and* HESS-BRIGHT *bearings.*



Two Worthington centrifugal compressors, each capable of handling the full 380-ton load; at right, one of the three Worthington chilling machines.

How Socony-Vacuum Gives Wax the Cold Shoulder

For the new addition to its Paulsboro refinery, Socony-Vacuum and its process engineers and constructors, E. B. Badger & Sons Co., found the *right* chilling equipment in Worthington's complete line.

Here's how this modern plant meets the 380-ton refrigeration load required by its solvent dewaxing process.

Plant propane is alternately condensed and vaporized in a closed cycle. The liquid propane, boiling at a low pressure and a constant temperature of minus 25F, surrounds the tubes in the Worthington inclined chiller through which the wax-bearing mixture is pumped.

Propane vapor, released in the chiller, is withdrawn to be compressed, with two liquid intercooling stages, from suction conditions of about 8 psig to a condenser pressure of 215 psig.

The compressors are four-stage Worthington centrifugal compressors. They are driven by 8420 rpm Worthington steam turbines which take steam from the plant mains at about 400 psig and exhaust at 40 psig back pressure to be used for heating purposes in other parts of the solvent recovery process.

Important installations such as this one are most likely to include Worthington refrigeration, because Worthington offers complete cycles for petroleum, chemical and petro-chemical applications, including centrifugal charge gas compressors for high pressure, condensers, coolers and exchangers.

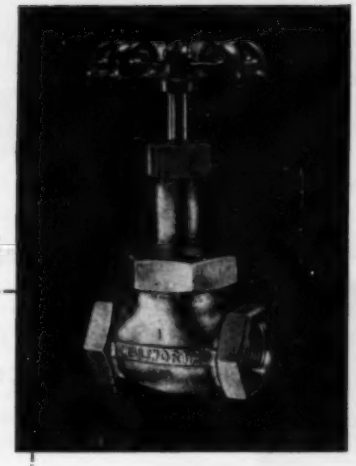
Take advantage of the *more worth in Worthington.* Write for bulletin to Worthington Pump and Machinery Corporation, Air Conditioning and Refrigeration Division, Harrison, New Jersey.

A-1-43

WORTHINGTON

THE ONLY COMPLETE LINE...ALWAYS THE CORRECT RECOMMENDATION

IDENTIFICATION DISC: An aluminum marking plate on all Walworth No. 225P's facilitates inventory control and makes reordering quick and positive.



take a good look at the Walworth "500 Brinell" no. 225P Globe

NEWLY DESIGNED HANDWHEEL: Patented air-cooled, finger-fit handwheel affords sure grip even with greasy gloves.

– the Toughest Bronze Valve Your Money Can Buy

The stainless steel, corrosion resistant seats and discs are heat treated to a hardness of 500 Brinell – hard enough to scratch glass and crush nails! The valve can be closed on sand, slag, and pipe scale without injury to the seating surfaces. "Wire drawing" is practically eliminated. All parts are accurately machined and gaged. Years of tight, positive shut-off are assured.

Available in both globe and angle types (angle type: No. 227P) in sizes ¼" to 2", this quality valve is recommended for 350 lbs. W.S.P. at 550 F, and 1000 lbs. non-shock service on cold water, oil, gas, or air.

For full data on this long-life, economical Walworth Bronze Valve, see your local Walworth distributor, or write for Circular.

IMPROVED PACKING: Molded packing of lubricated asbestos reinforced with copper wire. Suitable for practically every service. Valves can be repacked under pressure when fully opened.

note these 7 Great Features

HEXAGONAL UNION BONNET CONNECTION, DEEP STUFFING BOX AND RUGGED STUFFING NUT: Union bonnet connection eliminates any chance of distortion or leakage even though valve is repeatedly taken apart and reassembled.

OVERSIZE STEM: The high-tensile strength silicon-bronze stem assures long life and protection against wear.

SEATS AND DISCS: Plug type seats and discs of stainless steel, heat-treated to 500 Brinell hardness and machined simultaneously to a mirror-like finish, with accurate tapers assures tight positive shut-off with minimum handwheel effort.

EXTRA STRONG BODY: Made of Composition M (ASTM B61) bronze. Thick walls and rugged hexes provide a high safety factor. Valves undergo hydrostatic shell test of 1,000 psi.

WALWORTH

valves and fittings

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NOTES for Process Engineers

C. H. Wheeler OF PHILADELPHIA

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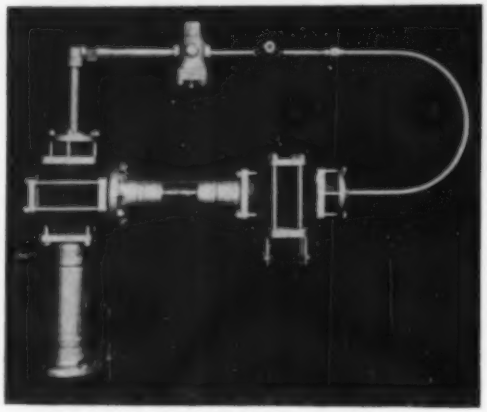


Two-stage non-condensing impervious graphite ejector

Send for catalog 1462. It contains helpful tables and tips on Steam Jet Vacuum problems. It also describes the complete line of C. H. Wheeler Tubejets. It will be mailed at no obligation to you.

STEAM JET EJECTORS
Made of IMPERVIOUS GRAPHITE For Handling CORROSIVE VAPORS

If your vacuum equipment is inefficient due to corrosion from acid fumes, this item holds an answer to your problems.

For highly corrosive acids such as sulphuric, hydrochloric, nitric, etc. C. H. Wheeler impervious graphite ejectors are recommended. The impervious graphite is enclosed in a steel or cast iron casing to prevent breakage. It is light in weight, non-porous, with low coefficient of thermal expansion and high resistance to thermal shock. Impervious graphite is most commonly recommended for the single and two-stage non-condensing ejectors.

C. H. Wheeler Ejectors can also be furnished of other materials such as acid resisting bronze, monel and stainless steel where the corrosive action of the vapors being handled does not require the use of impervious graphite construction.

"SELF-CLEANING" CONDENSERS *by* REVERSE FLOW featured in C. H. WHEELER Bulletin

The C. H. Wheeler Manufacturing Company's unique design of an integral reverse-flow steam condenser provides the most practical method yet devised for cleaning the tube sheet, and eliminates the need for expensive mechanical water straining apparatus. A recently issued bulletin tells how it works.

For C. H. WHEELER Literature
Attach this Handy Form to Your Company Letterhead

Interested in following literature

- ☐ Steam Jet Ejectors (catalog 1462)
- ☐ "Self-Cleaning" Reverse-Flow Steam Condensers

Your Name .....

Your Job .....

(Literature will be mailed to address shown on your company letterhead)

ANOTHER TOWER FOR CITY PUBLIC SERVICE BOARDS SAN ANTONIO, TEXAS. 13 Cell, 55,000 GPM Capacity to be Built by C. H. Wheeler for Gibbs & Hill, Inc., Engineers & Constructors

Following construction of two 7-cell Cooling Towers at the Leon Creek Power Station of San Antonio, Texas, C. H. Wheeler has been awarded the construction of a third and larger tower. The first towers were designed for 30,000 GPM. The new tower will handle 55,000 GPM to serve a 60,000 KW generator. It is a 13-cell induced-draft tower designed for 76.5° wet bulb, taking water at 105.5° inlet and cooling it to 90° outlet. Proposed construction is 39'8" x 364' x 29'. It will resist 30 lbs. per square inch wind pressure, or 100 mph hurricane force. Gibbs & Hill, New York are the engineers and constructors on the job.

C. H. WHEELER MANUFACTURING CO., 1808 SEDGLEY AVE., PHILADELPHIA 32, PA.

REPRESENTATIVES IN MOST PRINCIPAL CITIES

Cleaver-Brooks Compression Distillation . . . The Most Economical Method of Evaporation

Here's Why:

The table shows the approximate costs of operation per 1000 gals. of evaporated water with a Cleaver-Brooks Compression Evaporator as compared with standard multi-effect steam evaporators.

OPERATING DATA	STEAM EVAPORATORS					Cleaver-Brooks Compression Evaporation
	Single Effect	Double Effect	Triple Effect	Quadruple Effect	Quintuple Effect	
Pounds water evaporated per pound steam input from boiler	0.9	1.75	2.5	3.2	4.0	———
Pounds steam required per 1000 gallons water evaporated	9250	4750	3325	2600	2070	200
Gallons condenser water required per 1000 gallons water evaporated	33,300	16,650	11,100	8,325	6,650	none
Steam cost per 1000 gallons water evaporated, based on steam at $.80 per 1000 pounds	$7.40	$3.80	$2.66	$2.08	$1.66	$.16
Condenser water cost per 1000 gallons water evaporated based on water at $.10 per 1000 gallons	$3.33	$1.66	$1.11	$0.83	$0.66	none
Electric Power Consumption per 1000 gallons water evaporated	10 KWH	6 KWH	6 KWH	6 KWH	6 KWH	60 KWH
Electric Power cost per 1000 gallons water evaporated based on power @ $.01 per KWH	$.10	$.06	$.06	$.06	$.06	$0.60
Total Water & Energy cost per 1000 gallons water evaporated	$10.83	$5.52	$3.83	$2.97	$2.38	$0.76

The concentrating of chemical solutions for valuable recovery or for disposal can be done economically with compression distillation.

The recovery of pickling liquors, the concentration of waste proteins, the concentration of waste pulp liquors, are just a few of the process problems which can be solved through vapor compression distillation at less cost.

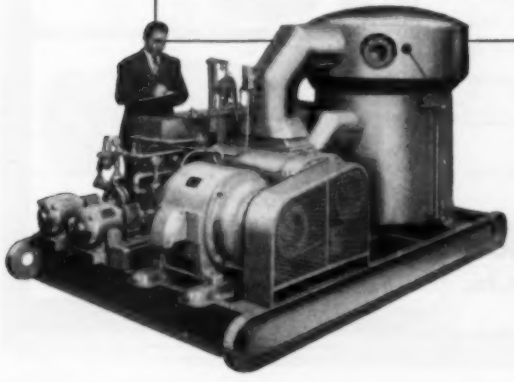
Cleaver-Brooks is constantly called upon to evaluate chemical process problems in terms of the vapor compression cycle.

After a complete analysis of your process problem, a Cleaver-Brooks compression still is constructed to meet your specific needs. Complete consideration is given to the type of raw liquid to be evaporated, the capacities of your allied equipment, the future growth of your plant operations, and the use or uses of the products to be distilled or concentrated.

It will pay you to consider now the value of compression distillation in your plant for purification or recovery or disposal.

Write for bulletin:
"Compression Distillation"

Cleaver-Brooks Company
331 East Keefe Avenue
Milwaukee 12, Wisconsin



Consider Compression Distillation for Purification... Recovery...Disposal

Cleaver-Brooks

Builders of equipment for the generation and utilization of heat.

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •

RUGGED Simplicity

Correctly engineered mechanically and metallurgically, all body assemblies of R-S Valves equal or exceed A. S. A. standards in every detail. These valves are designed and constructed for rugged service and provided with such safety factors that they will exceed service expectations as well as reduce pumping and blower costs.

Consider also the few working parts, greater control rangeability, the self-cleaning feature and the fact that R-S Valves are readily adapted to automatic operation. Know the rugged simplicity of R-S Valves, and get the most from your valve investment.

District offices are listed in telephone directories as, "R-S Products Corp'n Valves".

R-S PRODUCTS CORPORATION
4600 Germantown Avenue, Philadelphia 44, Pa.
An S. Morgan Smith Company Subsidiary

No. 782—Heavy Duty Rubber Seated Wafer Type Valve with 5° angle seated vane and enclosed gear reduction drive. Gland can be removed and stuffing box repacked without removing prime mover.

No. 739-740—Sixty-inch, 50-pound Heavy Duty Valve with gear reduction drive and handwheel for handling water at 40 psig. Vertical valve stem enclosed in steel pipe support. Thrust bearing absorbs vertical load.

No. 730—R-S Heavy Duty Floor Stand for rugged service in connection with any standard R-S handwheel operated valve.

No. 767—A 3-Way Valve (Two 24-inch 125-pound Cast Iron Valves bolted to 125-pound American Standard Tee). Electric motor operated by cross linkage. Automatic declutching handwheel for emergency operation.

NEW CORROSION-RESISTANT FITTINGS

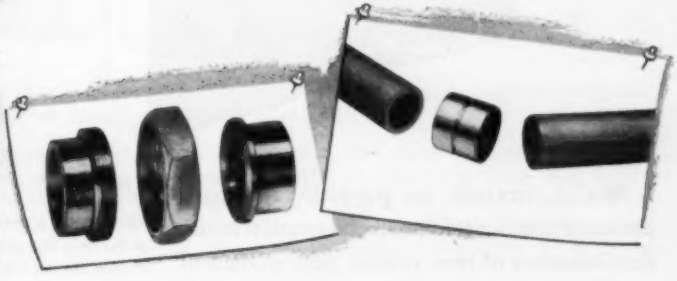
--the newest thing in pipeline economy

- *Improved piping layouts* with greater flexibility, plus increased capacity through the use of lightweight Schedule 5 pipe.
- *Lower first cost* when you compare *Speedline* fittings with others suitable for corrosion control applications.
- *Faster installation* that costs you less because of simplified construction that often eliminates welding, threading, etc.

These new fittings can help you conserve critical materials through the use of light-walled pipe and tube.

Write for a copy of the Speedline Fittings book which gives sizes, dimensions and cost comparison data on these fittings for use with O.D. tubing or pipe Schedules 5, 10 and 40.

*Speedline Insert Flange** with a corrosion-resistant serrated insert used in a carbon steel flange. Only tools needed are a plain wrench and expanding tool.



*Speedline Tube Union** solves leakage problems frequently encountered with corrosion-resistant ground joints.

*Speedline Aligning Connector** gives perfect alignment for tubing or I.P.S. corrosion-resistant piping, without butt welding.

* Patent applied for

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Speedline **Corrosion-Resistant FITTINGS**
—the newest thing in pipeline economy

the door is still open

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available for experimental work

We're anxious to provide adequate amounts of this useful material to assist in the development of new market potentials, and we're making every effort to supply sufficient quantities for such evaluation work.

In some cases it may not be possible for us to supply Visqueen to your exact specifications, in spite of our desire to do so. But we're trying.

So if your experiments call for a polyethylene film with many unique properties, write or wire or ask your Visqueen representative for details.

important! VISQUEEN film is all polyethylene, but not all polyethylene film is VISQUEEN. VISQUEEN is the only film produced by the process covered by U.S. Patent No. 2461975. Only VISQUEEN has the benefit of the research and extensive technical experience of The Visking Corporation, pioneers in the development of polyethylene film. Be sure. Always specify VISQUEEN film for superior tear and tensile strength and greater uniformity.

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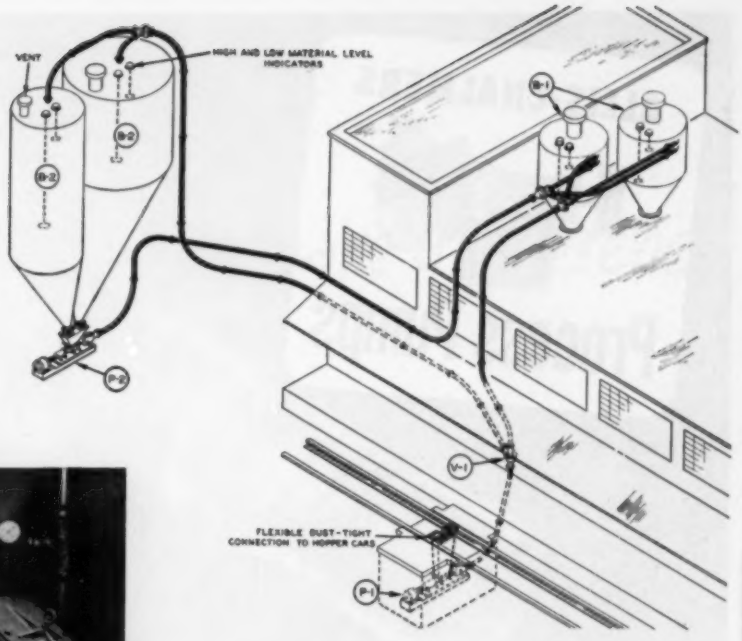
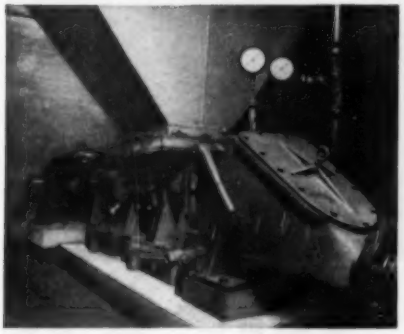
*T. M. The Visking Corporation

IF IT'S POWDERED... A FULLER-KINYON SYSTEM CAN PIPE IT!





A cement-products plant which receives Portland cement and fly ash in hopper-bottom cars. Materials are fed by gravity to a Fuller-Kinyon Pump (P-1) in pit below track. This pump conveys aerated materials, through the use of a two-way valve (V-1) in the conveying line, either direct to process bins (B-1) or to storage bins (B-2). A second Fuller-Kinyon Pump (P-2), below the storage bins (B-2) conveys materials from there to process bins (B-1).

safe • simple • clean • economical

For these reasons the Fuller-Kinyon System, pumping aerated powders, is the *best possible method of transporting such materials!*

Safe? A Fuller-Kinyon System has no hazardous moving parts. Absolute safety from explosion is assured. *Simple?* Flexibility of layout allows conveying pipe lines to be placed overhead, on simple hangers, or underground, to bins in any part of your plant. No bridges or monitors are needed, no changes in building layout or equipment. *Clean?* Material is always completely enclosed. There is no dust nuisance. *Economical?* Power consumption is low per ton of material handled. Maintenance costs are rock-bottom.

If you want to cut down your material handling costs, get in touch with a Fuller engineer. He'll study your layout and recommend the system that will best increase your handling efficiency. There is no obligation.

Typical materials handled:

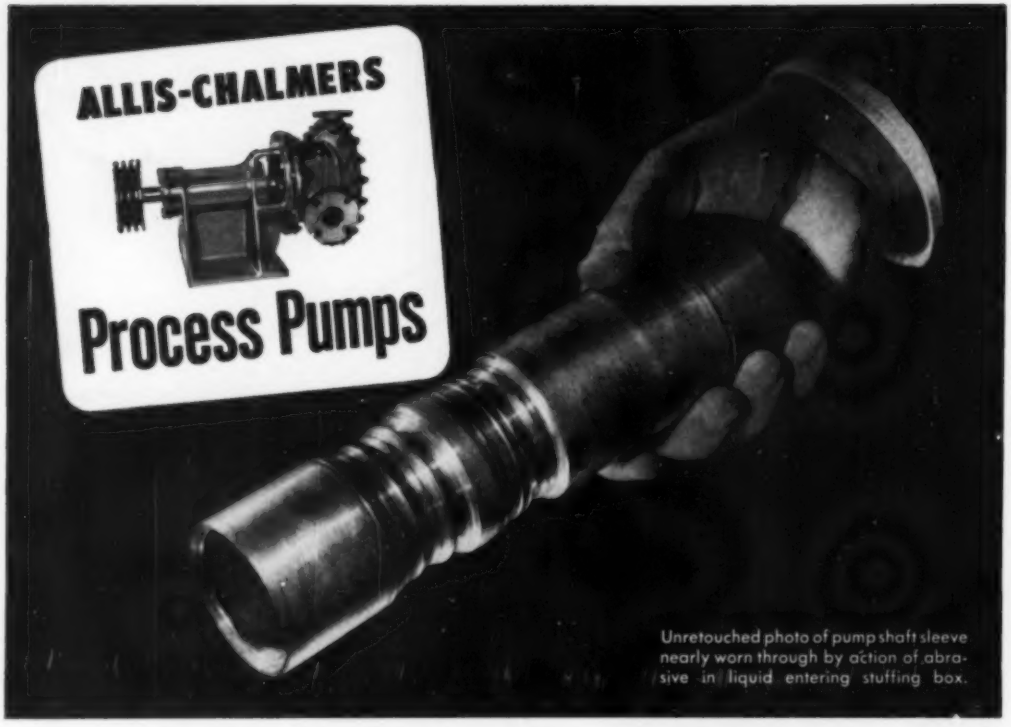
cement • chalk • clays • coke dust • dolomite • flue dust • fly ash • fuller's earth • graphite • gypsum • kaolin • lime • pulverized coal • rock dust • soda ash

FULLER COMPANY, Catasauqua, Pa.
Chicago 3 • 120 S. LaSalle St.
San Francisco 4 • 420 Chancery Bldg.

fuller

DRY MATERIAL CONVEYING SYSTEMS AND COOLERS
COMPRESSORS AND VACUUM PUMPS
FEEDERS AND ASSOCIATED EQUIPMENT

P-121



Unretouched photo of pump shaft sleeve nearly worn through by action of abrasive in liquid entering stuffing box.

STOP THIS WEAR

with *New EQUISEAL* Stuffing Box

KEEP ABRASIVES IN THE LIQUID BEING PUMPED entirely out of packing. Multiply packing life many times with new *Equiseal* stuffing box in Allis-Chalmers Process Pumps.

Here is how it works. An auxiliary rotor develops a low pressure area in front of the packing. For suction heads up to fifteen feet the pressure on the packing is zero. Consequently, the liquid being pumped will not enter the stuffing box while the pump is operating. Abrasives cannot ruin packing and shaft sleeve. Maintenance is cut to a fraction of that usually required on abrasive pumping jobs.

The *Equiseal* stuffing box is so effective that the packing may be removed while the pump is operating under positive suction head and the pump will not leak even though there is a direct passage from pump suction to atmosphere.

If you pump abrasives, you should know about the *Equiseal* stuffing box. Ask your Allis-Chalmers Sales Office for the details. Or write Allis-Chalmers, Milwaukee 1, Wisconsin for Bulletin 08B6615. A-3249

Equiseal, Texrope and *Vari-Pitch* are Allis-Chalmers trademarks.

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Applied . . .
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MOTORS — ½ to 25,000 hp and up. All types.

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and *Vari-Pitch* sheaves, speed changers.

A-C

ALLIS-CHALMERS

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When you place your order with Barrett you're assured prompt, dependable service and top quality products, backed by 96 years of successful manufacturing experience.

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Phenols	Phthalic Anhydride	Lutidines
Cresols	Dibutyl Phthalate	Tar Acid Oils
Cresylic Acids	ELASTEX* DCHP Plasticizer	Neutral Coal-tar Oils
Chlorinated Tar Acids	"ELASTEX" 10-P Plasticizer	Coal-tar Creosote
Xylenols	"ELASTEX" 50-B* Plasticizer	CUMAR* Paracoumarone-Indene Resin
Pickling Inhibitors	"ELASTEX" 28-P Plasticizer	Carbonex* Rubber Compounding Hydrocarbon
Benzol	Phenolic Resins	Bardol* Rubber Compounding Oil
Toluol	Niacin (Nicotinic Acid)	Flotation Agents
Xylol	Pyridines	
Naphthalene	Picolines	
Hi-Flash Solvent	Quinoline	

*Reg. U. S. Pat. Off.

Barrett

THE BARRETT DIVISION
ALLIED CHEMICAL & DYE CORPORATION
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"Moving" examples of **Flexible Connector jobs**

EXTENSION "FINGERS" FOR TIGHT SPOTS Have you ever dropped a screw or small part in a tight spot where your own fingers can't get at it? Then you'll appreciate these mechanical "fingers" which work around corners, even in a figure "8." They stay put, they grip and twist. Made by Aircraft Specialties, Inc., Lapeer, Michigan, from American 7/32 in. I.D. Lamp Arm Tubing.

The right move is to use American Flexible Metal Hose or Seamless Tubing wherever connectors must be flexible, absorb vibration, stand punishment of almost any kind. For close connections, for misaligned ports, for resisting heat, pressure and corrosion, let us suggest the right connector for the job.

Bulletins SS-50 and CC-300 contain information you ought to have about these versatile products. For your copies, write The American Brass Company, American Metal Hose Branch, Waterbury 20, Connecticut. In Canada: The Canadian Fairbanks-Morse Company, Ltd.

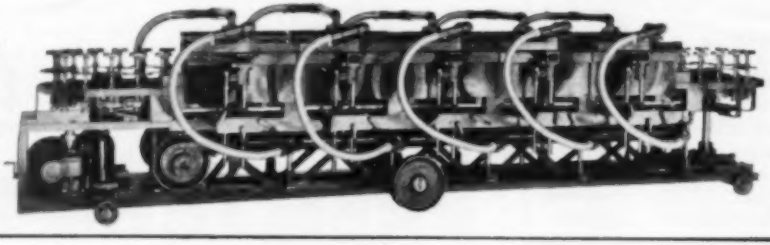
wherever connectors must move...

American ANACONDA

FLEXIBLE METAL HOSE AND TUBING

MOVES WITH VIBRATION — Lubricant is carried under pressure through 1-in. and 2-in. American Flexible Metal Hose Connectors to bearings and rolls of this 18-in., 4-high rolling mill. Vibration can never break these connectors.

TO "COOK" A SMOOTH DISH — American Flexible Metal Hose conveys gas to burners of this A. B. Knight glazing and polishing machine for finishing pressed tumblers, plates and dishes. Flexible connectors permit burner adjustment to products of varying size and shape.



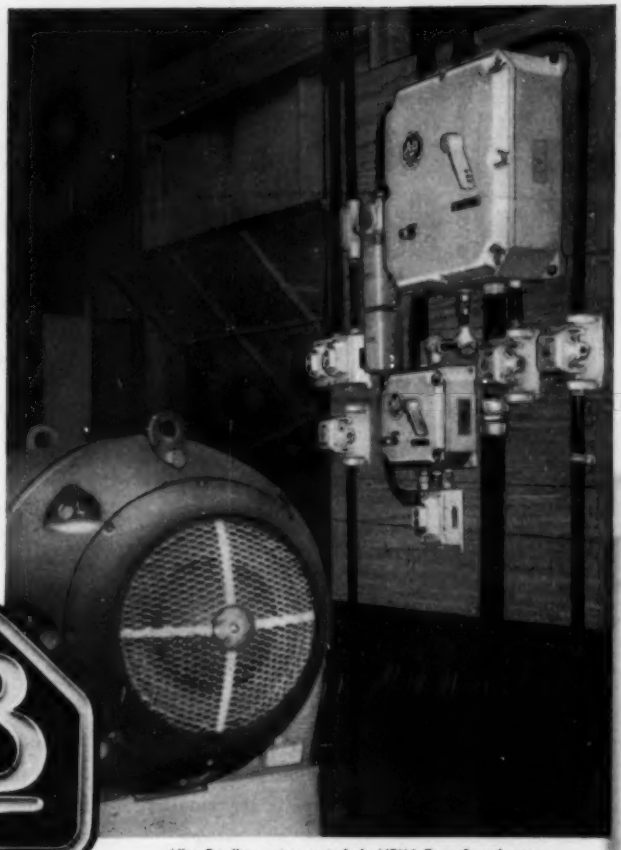
SAFE

MOTOR STARTERS for EXPLOSIVE ATMOSPHERES

Wherever hazardous dust conditions exist, Allen-Bradley motor controls in NEMA Type 9 enclosures should be used. These bolted enclosures, constructed of cast iron with wide machined flanges, provide maximum protection in explosive atmospheres.

Allen-Bradley solenoid motor starters and bolted enclosures are an ideal combination, because the double break, silver alloy contacts need no maintenance. The starters have only ONE moving part—no pins, pivots, bearings, or jumpers to cause trouble. Therefore frequent inspection is unnecessary. See the nearest Allen-Bradley control engineer, today, for his recommendations.

Allen-Bradley Co.
1337 S. First Street
Milwaukee 4, Wisconsin



Allen-Bradley motor controls in NEMA Type 9 enclosures installed in a North Carolina cereal processing plant.

A-B Quality

Allen-Bradley Automatic Starters are available in these enclosures

General Purpose

Watertight

Dust-tight

For Hazardous Locations

Corrosion- proof

For Hazardous Locations

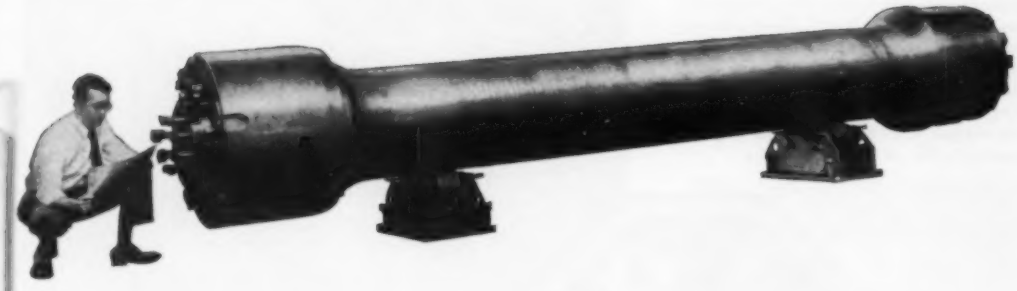
Dust-tight

ALLEN-BRADLEY
SOLENOID MOTOR CONTROL
QUALITY

NAME IT!

We'll Build the Pressure Vessel You Want

...in the size and type you want



When we solicit your inquiries on forged-steel pressure vessels, we offer a complete A-to-Z service that cannot be excelled anywhere in the industry.

This service includes, first of all, the making of the steel, carbon or alloy; then the necessary forging and treating; then the machining to specified dimensions; finally, the assembly and testing. Throughout these steps our engineers work closely with your own to be sure that the vessel shapes up exactly as you want it.

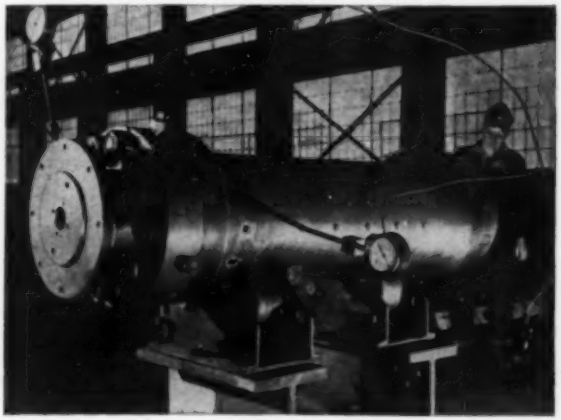
Bethlehem's facilities make it possible to build forged pressure vessels in virtually any size and type, and with any desired wall thickness. Small units or great multiple-section giants . . . we make them all. Seamless, rugged from end to end, they are built in complete conformity with your specifications.

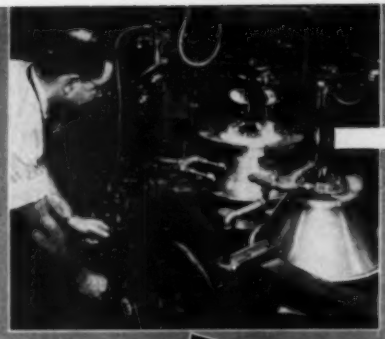
If considering vessels for the chemical industry, or for use in allied fields, see what Bethlehem has to offer. We'll be happy to co-operate in every way.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

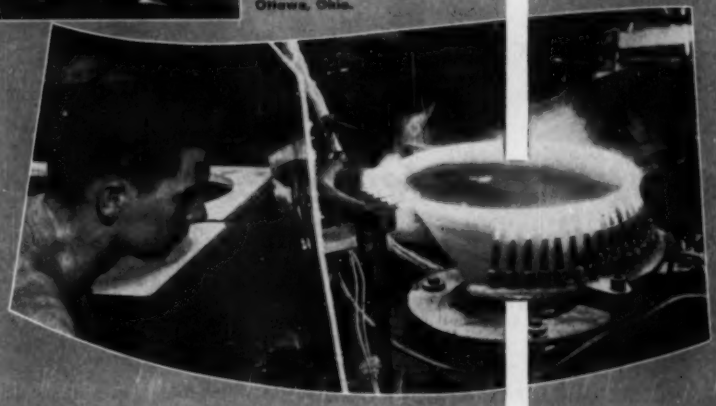
★ BETHLEHEM STEEL ★





Automatic rotary Gas sealing equipment at Sylvania assures a vacuum-tight, strong glass-to-metal bond.

Glass face of television tube is bonded to metal cone by GAS, at Television Picture Tube Division, Sylvania Electric Products Inc., Ottawa, Ohio.



GAS provides an Air-Tight Glass-to-Metal Bond on Sylvania's Television Tubes

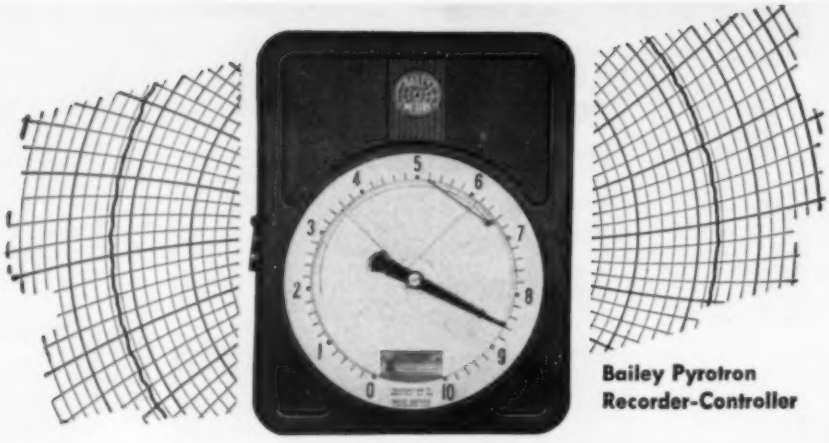
GLASS-TO-METAL BONDS must be strong and vacuum-tight for television picture tubes. Gas flames, impinging on the metal-glass surfaces, assure a dependable seal for Sylvania Electric Products Inc., Ottawa, O. and Seneca Falls, N.Y., picture tube plants.

Special Gas burners bring the temperature of the metal cone and the edge of the glass face to the proper temperature, allowing the glass to flow into the cone's spun-lip for an air-tight seal. To hold the proper face curvature and to prevent collapse, positive pressure maintained in the cone supports the face.

After fabrication, the tubes are screened and coated, and put through a high-temperature GAS oven where organic matter is baked out. The electron guns are then sealed in the tubes.

Where baking, tempering, annealing, and fusing-glass-to-metal are production-line steps, in your chemical and industrial processes, remember that the versatile, productive flames of GAS will serve you best. Get the facts from your Gas Company Representative. Call today.

AMERICAN GAS ASSOCIATION
420 LEXINGTON AVE., NEW YORK 17, N. Y.



Bailey Pyrotron
Recorder-Controller

Looking for Better Temperature Instruments?

...Then check these features of Pyrotron Electronic Resistance Thermometers...

FUNDAMENTAL ACCURACY

Bailey Pyrotron Resistance Elements are made of highest purity platinum—the material used by the National Bureau of Standards in establishing basic standards for temperatures from −190°C to +660°C.

THREE TYPES OF CONTROL

Pyrotron Controllers may operate: on-off electrical systems by either electronic relays or electric contacts, modulated electronic systems, or air-operated systems. Two temperatures may be recorded on the same chart and controlled by a single instrument.

FACTS PUT INTO USABLE FORM

Bailey Pyrotrons may be arranged to put temperature facts into convenient usable forms. If two or more temperatures are related, they may be recorded as continuous records on the same chart for easy comparison. The average of several temperatures or the difference between two temperatures may be recorded as a single continuous record which may be retransmitted to a distant point or used to actuate a control system.

EASY INSTALLATION

Bailey Pyrotrons do not require careful leveling or protection against vibration. Three ordinary copper wires are all that is needed to connect each temperature sensitive element with the recorder. Power may be taken from any 115 volt 60 cycle circuit.

MINIMUM MAINTENANCE

The absence of galvanometers, batteries and standardizing equipment, together with the use of interchangeable unit assemblies, reduces Pyrotron maintenance to the vanishing point.

ABUNDANT POWER

A separate motor drive for each temperature furnishes abundant power to operate a recording pen, a controller and an alarm switch.

For the full story on this unusual electronic resistance thermometer which is suitable for ranges between −300°F and 1200°F, ask for Bulletin No. 230-C. P-21

BAILEY METER COMPANY

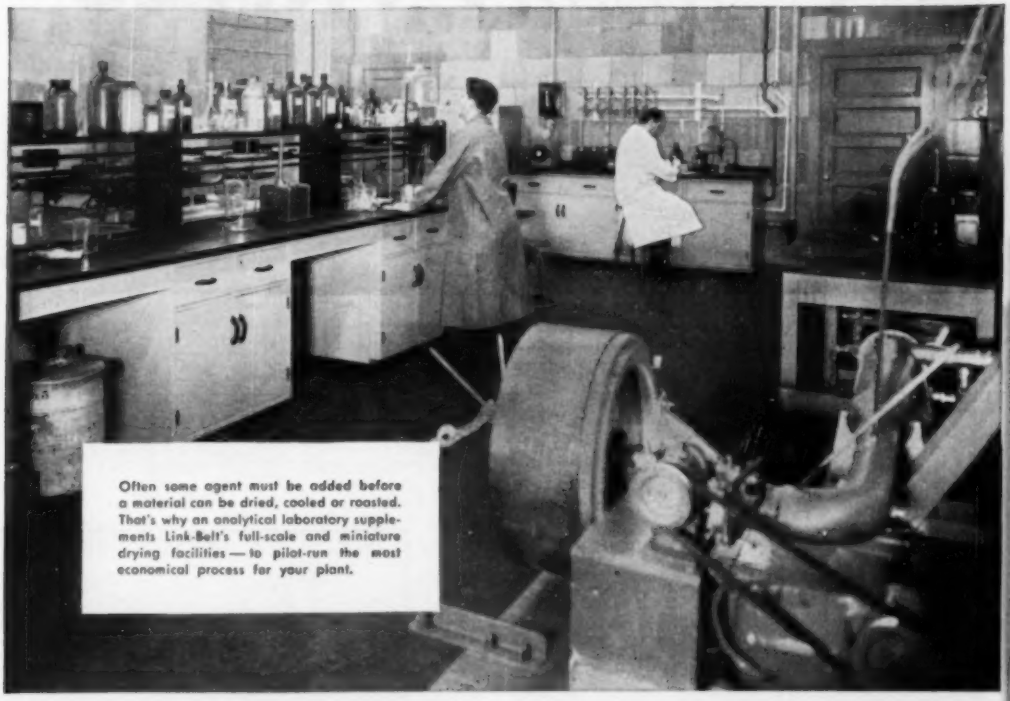
1054 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Processing

TEMPERATURE
PRESSURE
% OXYGEN
% COMBUSTION
FLOW
LEVEL
DENSITY
RATIO

AN INVITATION
to manufacturers with drying, cooling or roasting problems...

We'll tell you how your material can be dried economically



Often some agent must be added before a material can be dried, cooled or roasted. That's why an analytical laboratory supplements Link-Belt's full-scale and miniature drying facilities — to pilot-run the most economical process for your plant.

LINK-BELT can analyze and test-run your material in the laboratory, work out processes that can be duplicated in your plant...

Don't gamble — you can be sure in advance what equipment, what processes are needed to dry, cool or roast your materials profitably. Take advantage of these facilities . . . send a sample — a pound or a ton of your product to the Link-Belt laboratory today.

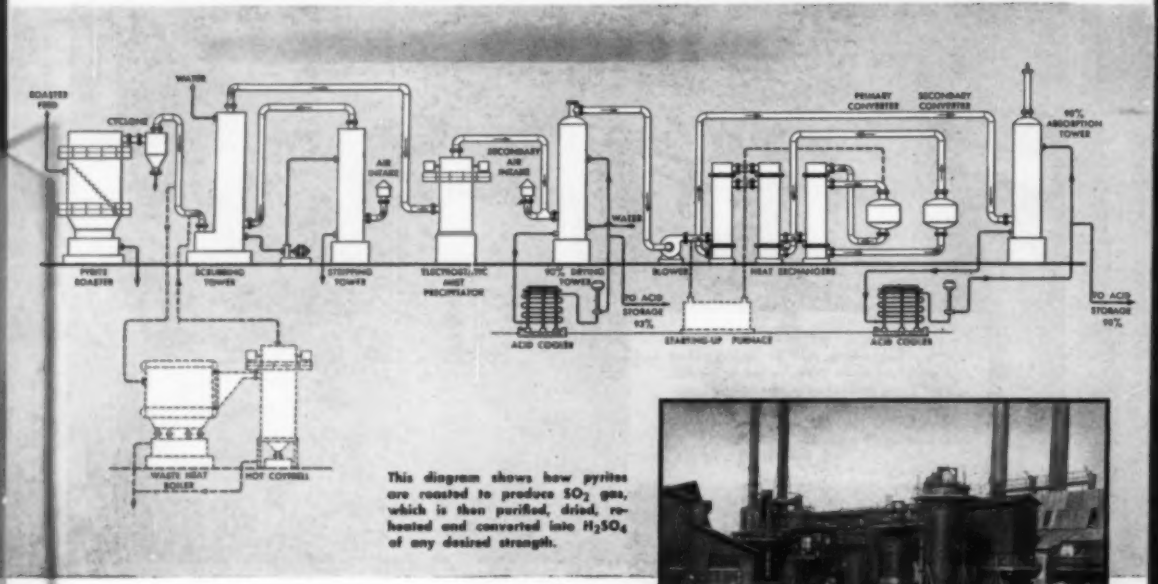
Capitalize on the know-how gained through more than 1000 product tests we've conducted in this laboratory. Tests and research that have resulted in the installation of 500 Link-Belt Dryers in the field . . . successfully processing 100 different materials.

If you can't send samples, we'll be glad to put a unit on loan right in your own plant. For complete information, call your nearest Link-Belt office or plant . . . today.

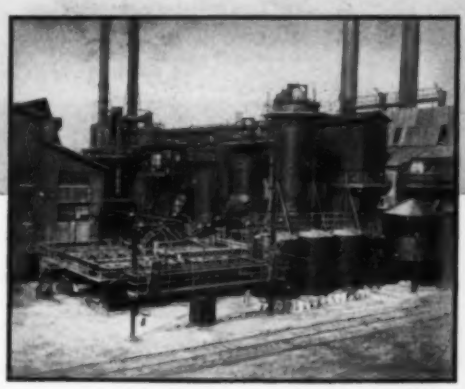
LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices in principal cities.

Another practical solution to the sulfur shortage

Make Sulfuric Acid from PYRITES



This diagram shows how pyrites are roasted to produce SO_2 gas, which is then purified, dried, re-heated and converted into H_2SO_4 of any desired strength.



HERE'S a practical answer to the sulfur shortage. With the Chemico acid process diagramed above, vitally needed sulfuric acid can be manufactured from ores such as pyrite, pyrrhotite and other metal sulfides which are in plentiful supply. The Chemico acid process can be adapted to use the sulfur dioxide gas from any preferred standard type of roaster.

Our wide experience in the design and construction of acid-making facilities enables us to deliver efficient plants on a performance-guaranteed basis.

For additional information on this Chemico process write for Bulletin S-102

CHEMICAL CONSTRUCTION CORPORATION

A UNIT OF AMERICAN CYANAMID COMPANY

488 MADISON AVENUE, NEW YORK 22, N. Y.

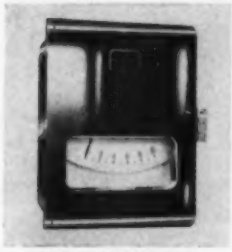
EUROPEAN TECHNICAL REPRESENTATIVE: CYANAMID PRODUCTS, LTD., LONDON W. C. 2, ENGLAND

CABLES: CHEMICONST, NEW YORK

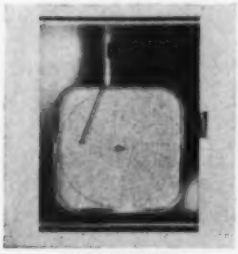
Chemico plants are profitable investments

CC-815

HOW TO SIMPLIFY PROBLEMS OF REMOTE MEASUREMENT AND CONTROL



THE TRANSMITTER



THE RECEIVER

Bristol Metameter* Telemetering Instruments Help Step Up Production... Save Time and Money... by Remote Measurement and Control of Pressure, Water Level, Flow, Temperature, Motion, Voltage, Current, Power and Totalized Load.

The Bristol Metameter Telemeter consists of three unit parts: Transmitter, Receiver, and interconnecting line which provides the electrical circuit between the two instruments.

The Transmitter is located close to the point of measurement. Its function is to transmit the readings to the receiver which can be any distance from a few feet to many miles away.

Readings can be transmitted over any two-wire circuit or its equivalent. Private wires, telephone circuits, radio (including microwave), or carrier current channels can be used.

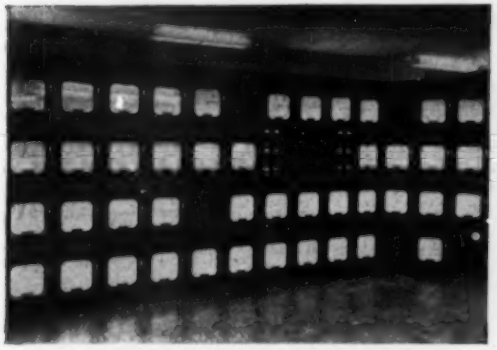
THE TRIED AND PROVED TELEMETERING SYSTEM. Bristol Metameter Telemeter is the product of 37 years of pioneering research and development work. Bristol's continuous program of engineering research and development keeps the Metameter abreast of modern requirements, making it the most reliable and widely used instrument in the field of telemetering.

A few of the thousands of Bristol Metameter Telemeter users:

Standard Oil (Indiana), Flintkote, Jones & Laughlin Steel, Bethlehem Steel, Corn Products Refining Company, Champion Paper & Fibre, Mathieson Chemical, New York Central System, McCarthy Chemical, Weirton Steel, Eastman Kodak, United Piece Dye Works, Freeport Sulphur, U. S. Weather Bureau, Bonneville Power Administration, Woodward Iron, Celanese Corporation, Anaconda Copper.

Reg. U.S. Pat. Off.

WRITE US FOR BULLETIN M1700. THE BRISTOL COMPANY, 109 BRISTOL ROAD, WATERBURY 20, CONN.

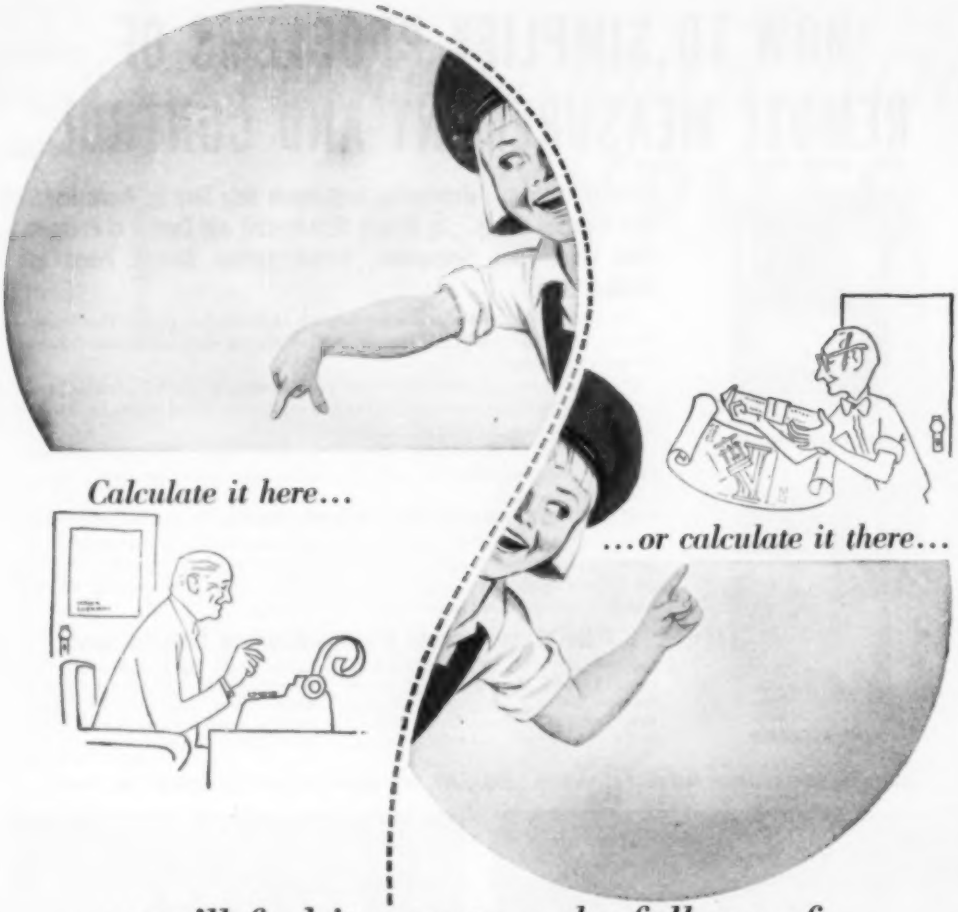


UNITED STATES STEEL COMPANY These Recording Metameter Receivers provide fuel dispatcher with information concerning gas fuel supply and demand throughout plant at Gary, Ind., help maintain highest production of steel with lowest fuel cost.

AT THE FORD PLANT Metameter Receivers used by the Ford Motor Company in dispatching gas throughout its Dearborn plant, bring readings of pressure and flow to central point for use of dispatchers. This installation has been in operation since 1936.

BRISTOL

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



...you'll find it pays to make full use of NATIONAL service on LEAD EQUIPMENT

Are you primarily concerned with costs ... or with processing?

In either case, you can save time, worry and expense by using NATIONAL service on any and all chemical lead equipment: piping, tanks, fittings, valves.

Take lead valves, for example, either hard lead or lead-lined ...

With NATIONAL service, you benefit from the engineering know-how of the leader in lead. You get valves and fittings designed to make the most of lead's inherent corrosion resistance. Sold as "United" valves and "United Tubond" flanged pipe and fittings.

With NATIONAL service, you benefit from the widest sort of application knowledge.

NATIONAL men work on acid handling problems in many plants all over the country.

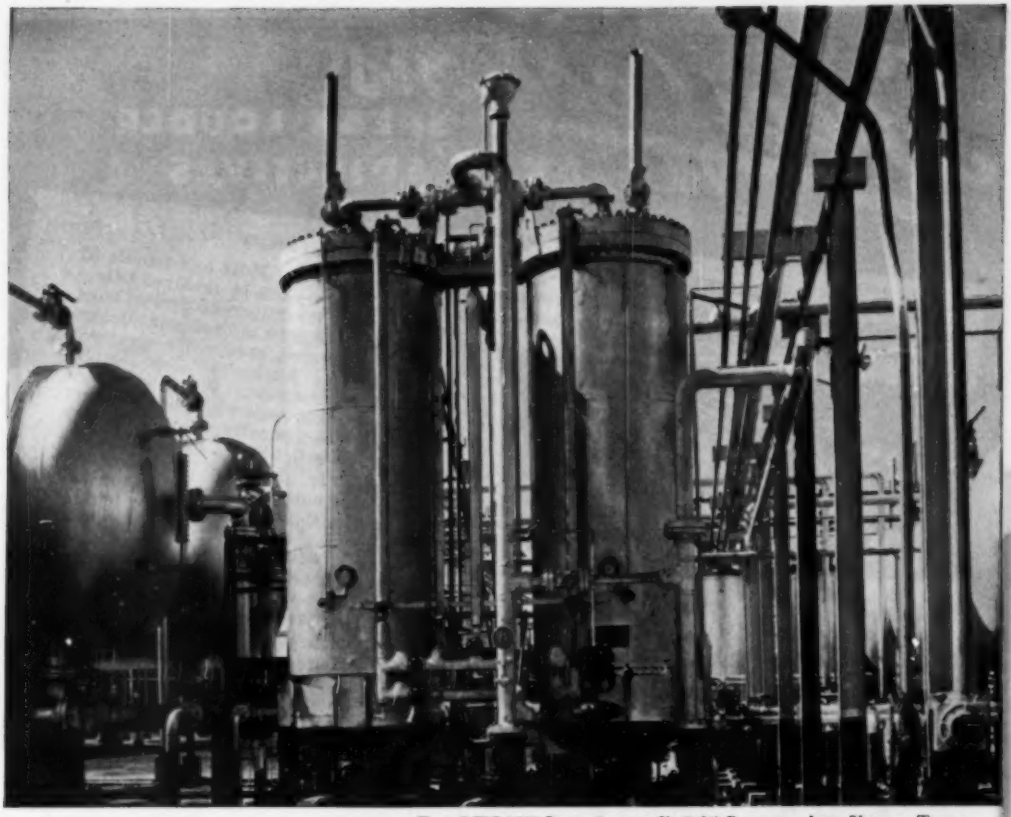
With NATIONAL service, you benefit from the resources of an organization that's NATIONAL in scope as well as in name. NATIONAL's strategically located plants and warehouses, its unexcelled sources of raw materials, its years of experience ... all add up to the kind of service you expect from the leader.

For lead valves or any other lead product ... remember the leader is NATIONAL.

Reg. U. S. Pat. Off.

NATIONAL LEAD COMPANY

New York 6; Atlanta; Baltimore 3; Buffalo 3; Chicago 8; Cincinnati 3; Cleveland 13; Dallas 2; Philadelphia 25; Pittsburgh 12; St. Louis 1; Boston 6 (National Lead Co. of Mass.); Los Angeles 23 (Morris P. Kirk & Son, Inc.); Toronto, Canada (Canada Metal Company, Limited)



Type BWC-3500 Lectrodryer at Shell Oil Company plant, Notrees, Texas.

DRYing propane at SHELL

Lectrodryers catch the moisture which separators and filters let by, DRYing hydrocarbons in either the liquid or gaseous stage. In this Shell Oil Company installation, liquid propane is processed.

Hydrocarbons for chlorination must be DRY, to prevent vicious attack of the steel in the chlorinators. Lectrodryers are placed on-stream to DRY them, therefore, as they pass on for further processing.

Hydrocarbons must be DRY before being fed into reactions where HF is the catalyst. And, in many cases, the purchaser specifies a DRY hydrocarbon for reasons of his own. Lectrodryers are doing all those DRYing jobs.

You can get extreme DRYness with Lectrodryers —down to 3 to 4 parts per million or less. Our engineers will help you lay out the system and select the proper equipment. For this help, write Pittsburgh Lectrodryer Corporation, 303 32nd Street, Pittsburgh 30, Pennsylvania.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In Australia: Birlec, Limited, 51 Parramatta Road, Glebe, Sydney.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

REGISTERED TRADEMARK U.S. PAT. OFF.

Specifications SPEAK LOUDER THAN ADJECTIVES

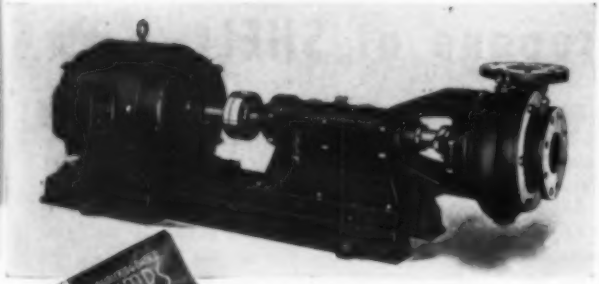
SPECIFICATIONS — BUFFALO FULL BEARING PUMPS

Casing: Solid shell volute type with removable suction side plate. Male and female fit insures perfect alignment of casing with supporting housing. Casing can be revolved before or after leaving the factory to give at least four different positions of openings. Unless otherwise requested, pumps are arranged with vertical up discharge. Can be furnished either rotation. **Wearing Rings:** Easily renewable wearing rings, protect casing from wear. **Impeller:** High efficiency enclosed type with liberal openings to pass abrasive solids. Enclosed impeller construction eliminates wear on the pump casing. Impeller mounted on shaft by feather key and lock nut and screw. Open impeller can be furnished where necessary, in which case wearing rings are omitted. **Bearing Housing:** Supporting head and bearing housing cast integral and bored at sa[illegible] operation insuring perma[illegible]

in "Buffalo" PUMPS

FOR ALLOY CONSTRUCTION

• A look at the specifications tells of the fine quality construction of Buffalo Pumps. Here you'll find the reasons for their easy maintenance and their suitability for long service. "Buffalo" Full Ball Bearing Pumps are available in a wide variety of alloys. For lowest cost in pumping your special liquids, write for BULLETIN 982 and let the specifications tell the story.



"Buffalo" PUMPS

BUFFALO PUMPS INC.

501 BROADWAY, BUFFALO, NEW YORK

Canada Pumps Ltd., Kitchener, Ont.

Branch Offices in all Principal Cities

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

A Bedtime Story for Very Junior Chemists

Once upon a time, there lived a sad little Sodium CarboxyMethylCellulose. He worked very hard extending Soaps and improving Synthetics. But all the Soaps called him a "war baby." And he wasn't allowed to associate with any but Low Grade Synthetic Detergents.

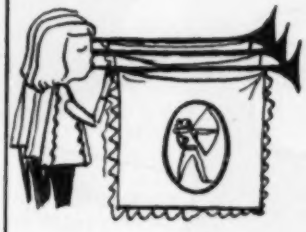
So he ran away. And arrived one day on the Doorstep of a Corporation in Wyandotte, Michigan. The Corporation picked him up and handed him over to the Research and Development Division. Well, you should see what they did for this little "war baby"!

They changed his length and Molecular Structure. They Manufactured him by a brand new Process. They let him associate with High Grade Synthetic Detergents. And then they gave him a name . . . "Carbose*."

*Reg. U. S. Pat. Off.

Carbose might have been very happy—but the Soaps still put on airs. "No matter how hard you and those Synthetics try," the Soaps told him, "nothing cleans as well as Soap."

But he worked hard just the same. He practiced Soil Removing and Whiteness Retaining and all the other things a detergency promoter should. And one great day, the Research and Development Division called the Soaps and Synthetics together and read a Proclamation:



"Synthetic Detergent products can be formulated with Carbose which will yield detergency equal to that of High Grade Soaps under conditions favorable to Soap, and far superior to High Grade Soaps under conditions unfavorable to Soap."

"Carbose!" Why, they were talking about him! Carbose was a hero! Yes, it was a great triumph for him . . . but Carbose went on . . . had a large family and did many more things . . . in textiles, paper, paints, ceramics, petroleum . . . and even in soap!

Soda Ash • Caustic Soda • Bicarbonate of Soda • Calcium Carbonate • Calcium Chloride • Chlorine • Hydrogen • Dry Ice Synthetic Detergents • Glycols • Carbose (Sodium CMC) • Ethylene Dichloride Propylene Dichloride • Aromatic Sulfonic Acid Derivatives • Other Organic and Inorganic Chemicals

WYANDOTTE CHEMICALS CORPORATION
Wyandotte, Michigan Offices in Principal Cities

Wyandotte
REG. U. S. PAT. OFF.

So if you are looking for a chemical with applications involving viscosity regulation, colloid stabilization, surface finishing, or detergency, why not write to us about Carbose?

A Big Forward Step In The Measurement and Transmission of Flow

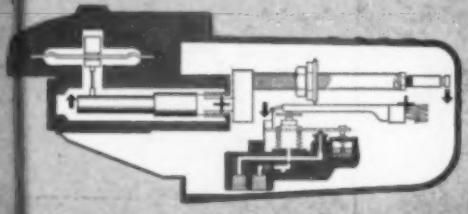
INTRODUCING *the New*

BROWN DIFFERENTIAL CONVERTER

(pneumatic-balance flow transmitter)

Easy Field Calibration –without water column

No Strainers Required



Functional schematic cross-section of the Brown Differential Converter . . . showing its utilization of the pneumatic-balance principle.

Easily Cleaned

Wide Rangeability –in one unit, 20 to 200" H_2O

Fast Speed of Response

Easy to Install

No Mercury or Seals

AFTER long and rigorous testing in the field, the Brown Differential Converter is ready to set new high standards of simplicity and precision in the measurement and transmission of flow.

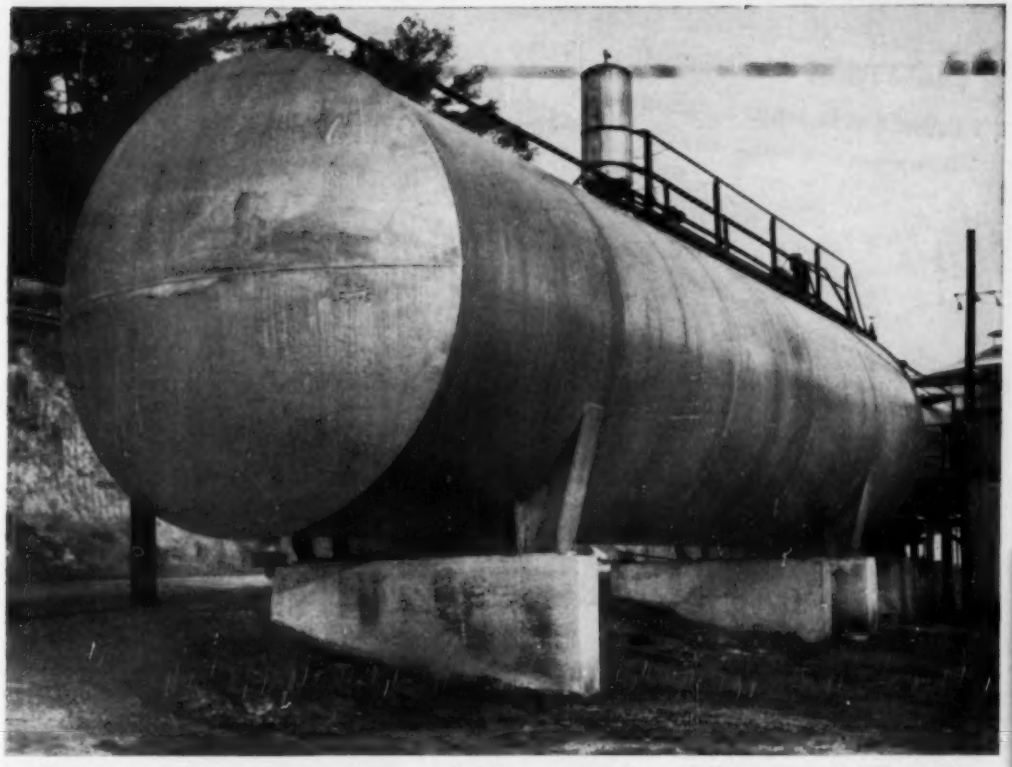
Operating on the pneumatic-balance principle, this compact and lightweight unit converts differential pressure at the orifice into a proportionate output air pressure which is a measure of flow. Range is continuously adjustable, from 0-20 to 0-200 inches of water. All adjustments are easily and simply made, without special tools or extra parts.

Applicable to a wide range of continuous processes, the Brown Differential Converter is the forerunner of an entirely new series of pace-setting developments made possible through Brown *Creative Instrumentation*. For detailed information write for a copy of new Catalog 2281 . . . and call in our local engineering representative for a discussion of your process needs. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4478 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS



Store Ammonium Nitrate in Horton Tank

Hercules Powder Company manufactures industrial explosives at its Bessemer, Alabama, plant. Contamination of the materials used in the manufacturing process not only could affect the quality of these explosives—it could be dangerous too. So, at this plant, Hercules stores ammonium nitrate solution, an important ingredient for explosives, in the Horton* tank shown above.

This tank is made of aluminum and is 12-ft. in diam. by 50-ft. long. Aluminum was specified to prevent metallic contamination of the strong ammonium nitrate solution. It is also non-sparking, an important factor in the handling of ingredients for explosives.

Aluminum is one of several corrosion-resistant alloys we use to build tanks and other chemical plant equipment. The others are listed at the right.

We also build such carbon steel plate structures as flat-bottom tanks, elevated water tanks and pressure storage tanks. Write our nearest office for information or quotations on any of this equipment.

** Trademark Registered in U. S. Patent Office*

We are equipped to fabricate and erect storage tanks and process equipment from the following corrosion-resistant metals.

- CLAD STEELS — Chrome-nickel or straight chrome stainless steels, monel, or nickel.
- LININGS — Chrome-nickel, straight chrome or ELC (extra low carbon) stainless steel, monel or nickel.
- SOLID METALS—Chrome-nickel, straight chrome or ELC stainless steel, monel, aluminum or nickel.

You are invited to write our nearest office for information or quotations.

CHICAGO BRIDGE & IRON COMPANY

Atlanta 3.....2120 Healey Bldg.
Birmingham 1.....1510 North Fiftieth St.
Boston 10.....1005—201 Devonshire St.
Chicago 4.....2124 McCormick Bldg.
Cleveland 15.....2220 Guildhall Bldg.
Detroit 26.....1503 Lafayette Bldg.
Houston 2.....2103 National Standard Bldg.
Los Angeles 17..1505 General Petroleum Bldg.
New York 6.....3318—165 Broadway Bldg.
Philadelphia 3...1625—1700 Walnut St. Bldg.
Salt Lake City 4.....505 West 17th South St.
San Francisco 4.....1522—200 Bush St.
Seattle 1.....1305 Henry Bldg.
Tulsa 3.....1623 Hunt Bldg.
Washington 6, D. C.....1160 Cafritz Bldg.

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

Rates of Fouling and Cleaning of Unfired Heat-Exchanger Equipment
CLEANING TUBULAR HEAT EXCHANGERS
by P. F. Dougherty and C. H. Brooks
Fouling Rates in Heat Exchangers
Cleanliness in all Exchangers Essential To Maintain High Heat Transfer Rates

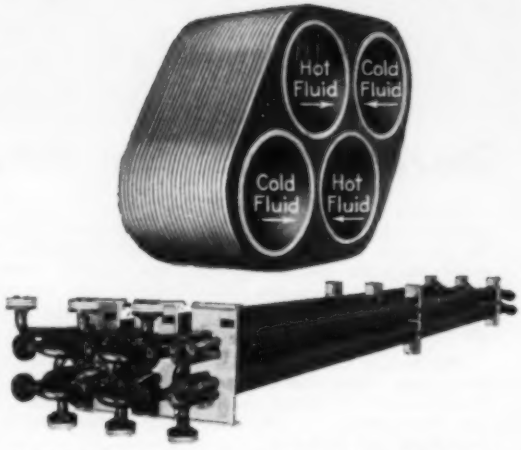
No Problem with the

G-R TUBEFLO SECTION

Maintaining the capacity of conventional heat exchangers that handle dirty, tarry or other clogging liquids is a constant problem to plant engineers. The articles quoted above are proof of this. But you don't have to worry about fouled tubes when you use a G-R Tubeflo Section.

In the G-R Tubeflo Section, each tube is a single pass, and all passages, including return bends, are of uniform area, so that continuous high velocity of the fluids sweeps tar or sediment completely through the unit. In many installations, these units are maintaining initial capacity indefinitely on services which previously necessitated shut-down and cleaning of conventional tubular units before the end of a single run.

Only the G-R Tubeflo Section gives you greatest freedom from clogging. It also positively prevents interleakage and contamination of fluids. And these are just two of the many important advantages this unit offers for heating or cooling heavy or sediment-bearing liquids. Bulletin 1622 fully describes the G-R Tubeflo Section. Write for your copy today.



IN THE G-R TUBEFLO SECTION each fluid flows through two parallel tubes in a single pass per tube. The two pairs of tubes are expanded into closely-spaced diamond-shaped fins which bind the four tubes together and transfer the heat from the hot tubes to the cold tubes. All pipe connections are at one end of the unit, and the return end of the unit floats freely on changes in temperature.

THE GRISCOM-RUSSELL CO., 285 MADISON AVENUE, NEW YORK 17, N. Y.

GR-220

GRISCOM-RUSSELL

PIONEERS IN HEAT TRANSFER APPARATUS

When Choosing V-Belts Remember These Two Words ...They Mean Exactly What They Say!

"DEPENDABLE RUGGEDNESS" didn't get into the BWH trade mark by accident. It means *precisely* what it says . . . Bull Dog V-Belts assure steady, smooth, low cost power transmission — *uninterrupted by premature belt failure.* You save on maintenance costs, keep the wheels of power moving!

TOUGH PROBLEMS INVITED — Ask us or your nearest BWH distributor about your power transmission belting, conveyor belting and hose problems. We're specialists in making mechanical rubber products work *better, longer.*

- **SPECIALLY ENGINEERED BWH CORD SECTION**
  Noted for high tensile strength. *Benefit:* superior load carrying capacity, ability to absorb shock loads, uniform matching when used in sets.
- **MINIMUM STRETCH**
  Results from a new, exclusive technique in processing Bull Dog Cords. *Benefit:* reduced slippage, a minimum of adjustments, longer belt life.
- **DURABLE COVERS**
  The secret's in the closeness of weave of the heavy, bias cut fabric. *Benefit:* it can take the severe wearing action of the sheave while sealing the belt against moisture, dirt and grease.
- **WITHSTANDS SEVEREST FLEXING**
  The "reason why" here is due to constant research in the development of quality - controlled compounds by BWH. *Benefit:* these compounds run cooler and do not crack or deteriorate under severe flexing.

For these reasons make your next V-Belt purchase order read "Bull Dogs" — and buy them by the set!

Another Quality Product of

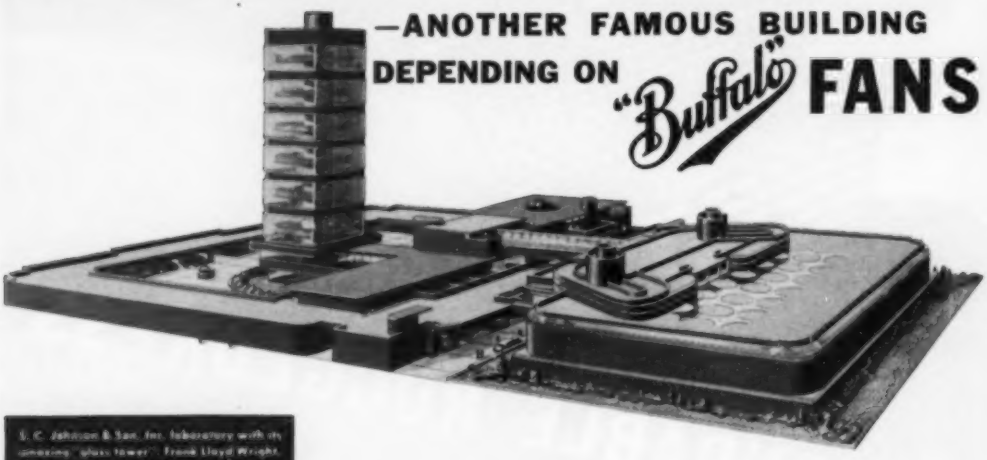
BOSTON WOVEN HOSE & RUBBER COMPANY

Distributors in all Principal Cities

PLANT: CAMBRIDGE, MASS. • P. O. BOX 1071, BOSTON 3, MASS., U. S. A.

JOHNSON'S WAX RESEARCH TOWER

—ANOTHER FAMOUS BUILDING DEPENDING ON "Buffalo" FANS



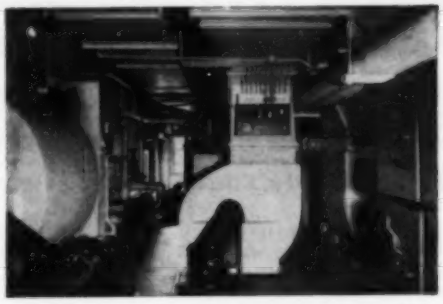
S. C. Johnson & Son, Inc. laboratory with its amazing "glass tower". Frank Lloyd Wright, Architect. Samuel R. Lewis, Consulting Engr. Fans by Buffalo Forge Company

15 stories with glass and brick walls, the entire structure suspended by means of a concrete "core" running down through the center—the Johnson's Wax Research Tower is one of the structural marvels of mid-century! Designed in behalf of the American Housewife, the tower enjoys conditioned, dust-free air at all times. "Buffalo" fans supply the air.

"Buffalo" Fans are putting air to good use in every type of plant—improving product and process control—promoting health and safety—stepping up worker productiveness—increasing profits. And they are doing it efficiently.

Write us about your job for air. There's a "Buffalo" Fan or Air Conditioning unit to handle it to your satisfaction!

"Buffalo" Axial Flow Fans are popular both for light-duty ventilation and air conditioning work



"Buffalo" LL Fans are widely used to suppply air for air conditioning units, like these insulated fans

"Buffalo" FIRST FOR FANS

BUFFALO FORGE COMPANY

501 BROADWAY, BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont. Branch offices in all Principal Cities

VENTILATING FORCED DRAFT | AIR WASHING COOLING | AIR TEMPERING HEATING | INDUCED DRAFT EXHAUSTING PRESSURE BLOWING

Useful Information About A Sulphuric Acid-Resisting Stainless Steel

This new 20-page book contains complete information about Carpenter Stainless No. 20 in all forms, sheet, plate, tubing, bar stock, etc. If you now have the typewritten bulletin about No. 20, be sure to replace it with this book containing information never before published. While the use of Stainless No. 20 is limited under present conditions, we want to keep you up-to-date on its performance.

This book contains many field reports describing No. 20's resistance to corrodents such as

Acetic anhydride	Mixed acids
Alkylate	Phosphoric acid
Fluoborate solutions	Sulphuric acid
Maleic acid	Zinc phosphate, etc.

For your copy, just write us a note on your company letterhead.

THE CARPENTER STEEL COMPANY

Alloy Tube Division, Union, N. J.

Export Department: The Carpenter Steel Co., Reading, Pa. "CARSTEELCO"

Carpenter

STAINLESS NO. 20

Licensed under patents of The Durion Co., Inc.

New compressor design cuts refrigeration costs

The new Carrier 5-J Compressor represents the biggest improvement in reciprocating compressor design in years. Developed especially for commercial applications requiring from 75 to 200 horsepower in single units, the 5-J has already introduced many exclusive refrigeration economies.

The Carrier 5-J is highly efficient at both full and partial loads, giving lower brake horsepower per ton of refrigeration. This means you can now use one unit rather than several smaller compressors. You realize savings in piping, valve fittings and electrical wiring and control items.

Here are other unique design features of the new 5-J compressor which is setting new standards for low-cost, heavy-duty refrigeration.

Precision built parts and dynamically balanced crankshaft almost eliminate vibrations. Under most conditions, installation can be on upper floors.

Takes any type of drive. Can be powered by motor, gas or Diesel engine, or steam turbine with gear. May be operated as dual units from single motor with a double shaft.

Replaceable wearing parts. Every moving part subject to wear is easily and quickly replaced.

Vapor cushioned valves. Exclusive feature provides quiet operation and longer life.

Positive pressure lubrication. Built-in oversize pump forces oil under pressure to all moving parts.

Oil cooler and cleanable oil filter with by-pass cools and filters all oil to bearings.

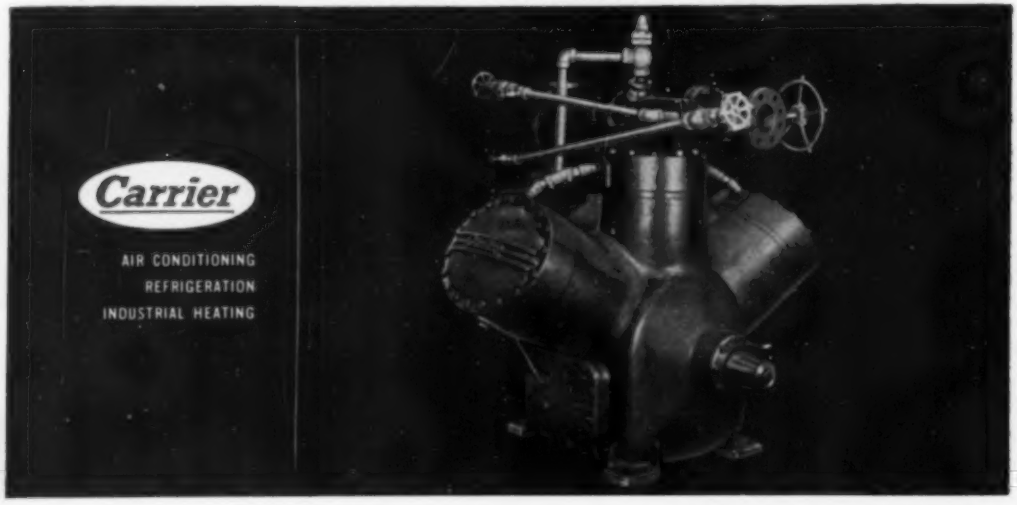
Water-jacketed cylinder heads minimize suction gas preheating and carbonization of oil on discharge valves.

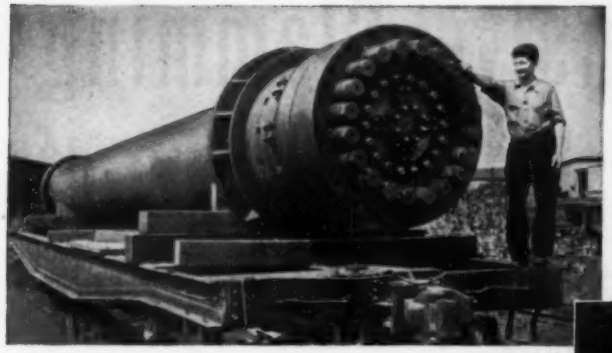
Manual load leveler allows operator to vary compressor capacity in direct response to suction pressure. These controls can be made automatic.

Uses most refrigerants—Ammonia, "Freon-12," "Freon-22," "Carrene 7" and many others.

For more complete information about the new Carrier 5-J Compressor, call your Carrier representative or write for folder No. 5J20 to Carrier Corporation, Syracuse 1, N. Y.

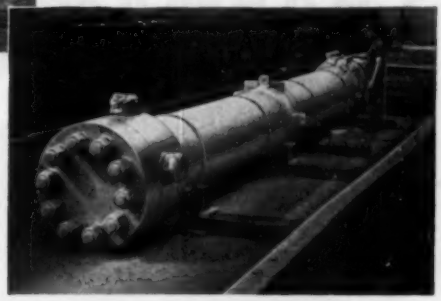
Shown here is the new Carrier Ammonia Compressor.





One of several MULTI-LAYER Converters designed for 5000 psi working pressure, with corrosion-resistant type 405 alloy inner shell. Wall thickness 8¼ inches, weight 182,000 lb. This type of construction is ideal for high pressure synthesis of coal and shale.

MULTI-LAYER Heat Exchanger designed for 5100 psi working pressure. Wall thickness 4¾ inches, weight 45,800 pounds.



A.O.Smith
MULTI-LAYER
Heat Exchangers & Pressure Vessels

The practical, *economical* solution to your high pressure process and storage requirements

MULTI-LAYER vessels are built-up from concentric layers of relatively thin steel plate, progressively *wrapped, tightened* and *welded* around an inner, pressure-tight cylinder.

Greater range of process possibilities for the planning and design engineer are provided in this unique, patented construction.

Walls can be made stronger merely by increasing strength of steel wrapping plates or by adding more layers.

For corrosive service, only the inner cylinder need be fabricated of alloy or non-ferrous materials.

No size or weight limitations as MULTI-LAYER vessels or heat exchangers can be made in any diameter for which satisfactory end closures are available.

The full calculated strength of the steel is more fully utilized in MULTI-LAYER vessels. Wrapping tension and weld shrinkage develop compression in the inner layers. This results in more equalized loading of all portions of the vessel wall under working pressure.

Safety is greatly improved by MULTI-LAYER construction. Only the inner cylinder need be pressure tight! Outer layers are provided with vent holes which protect the vessel against damage from over-pressure. In the remote event of run-away overload sufficient to cause failure, there is little danger of fragmentation of the vessel wall, due to the nature of MULTI-LAYER construction.

Consult A. O. Smith for assistance on your heat-exchanger or pressure-vessel problems. In any event, write for Bulletins V-52 and V-53 for more complete information on MULTI-LAYER Pressure Vessels and their construction . . . or use handy coupon.

A.O. Smith 77th Anniversary 1874 - 1951

A.O.Smith

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Dept. CE-451, Milwaukee 1, Wis.

Without obligation, send me Bulletins V-52 and V-53 on your MULTI-LAYER Pressure Vessels and their construction.

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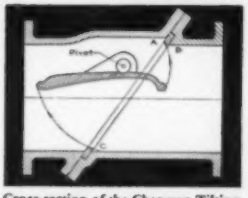
Stop Expensive Slamming With the Cushioned Closing of CHAPMAN TILTING DISC Check Valves

Those words — *cushioned closing* — best describe the action of this unique check valve. The tilting disc works with the stream—opens easily, closes quickly, *yet quietly.* There's no slamming — no resultant destructive stresses on the pipeline.

As a result of this smooth, *cushioned action,* maintenance costs are at a minimum and savings of from 65% to 80% in head losses can be obtained over conventional-type check valves.

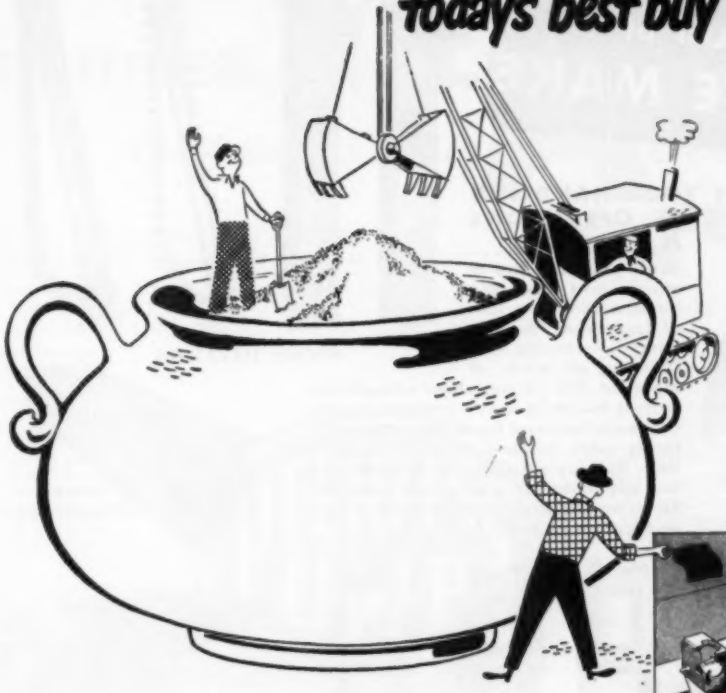
Send today for the bulletin describing this unusual valve.

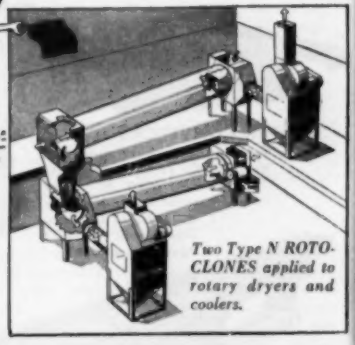
THE CHAPMAN VALVE MFG. CO.
INDIAN ORCHARD, MASSACHUSETTS



Cross-section of the Chapman Tilting Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

today's best buy is better air!





Two Type N ROTO-CLONES applied to rotary dryers and coolers.

refinery salvages 14 TONS daily
WITH ROTO-CLONES!

A LARGE CUBAN sugar refinery salvages 28,000 lbs. of sugar in a 24-hour day with three AAF ROTO-CLONES*. The high efficiency of the ROTO-CLONE in the collection of process dust particles ranging from coarse to extreme fines makes it ideal for many applications in chemical industries, where dust *should* be salvaged . . . or *must* be eliminated.

The many types and sizes of ROTO-CLONE dynamic precipitators, which include both wet and dry type collectors, provide solutions for nearly every dust source or air pollution problem. Here are some of the many dust sources which ROTO-CLONES efficiently control: BLENDING . . . COATING . . . COMPRESSING . . . CONVEYING . . . FILLING . . . HAND MOLDING . . . PACKAGING . . . SCREENING . . . SHAKING . . . TRANSFER POINTS . . . WEIGHING.

Perhaps the experience of the Cuban refinery will spark an idea for ROTO-CLONE applications to your own problems. Your nearby AAF representative will be glad to discuss these with you and make recommendations based on the company's thirty years of experience in dust control. Call him today.

• • •

**ROTO-CLONE is the trade-mark (Reg. U. S. Pat. Off.) of the American Air Filter Company, Inc., for various dust collectors of the dynamic precipitator and hydro-static precipitator types.*

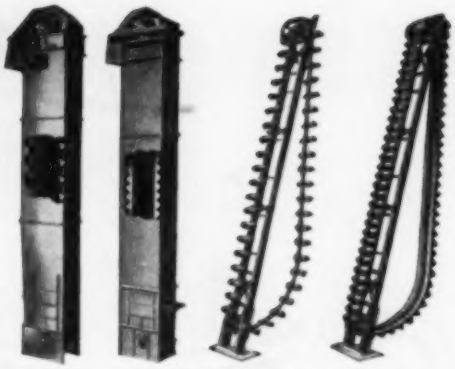
AAF **American Air Filter**
COMPANY, INC.

326 Central Avenue, Louisville 8, Ky. • In Canada: Darling Brothers, Ltd., Montreal, P. Q.

Partial List of

WHAT WE MAKE

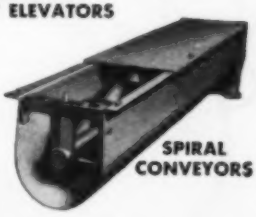
TO HELP YOU IN YOUR HANDLING AND PROCESSING OPERATIONS



BUCKET ELEVATORS

BELT CONVEYORS—IDLERS

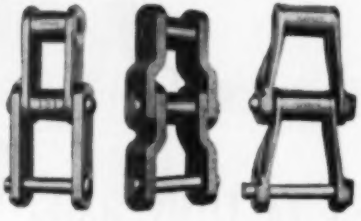
Check these items . . . likely you need one or more right now. We build a complete line of equipment for handling, processing and reducing all kinds of material. We cannot show everything Jeffrey builds to speed production and cut costs, but send for Booklet No. 832 for a quick picture of our extensive line. Jeffrey's engineering facilities are available for laying out complete handling and processing systems or the application of individual units.



SPIRAL CONVEYORS

SCRAPER CONVEYORS

For handling bulk material horizontally or on incline, discharging at fixed point through valves in trough bottom. Also wood or steel Apron Conveyors.



CHAINS SPROCKETS ATTACHMENTS

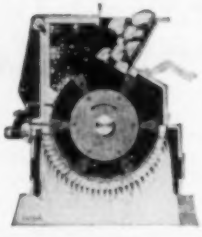
FEEDERS—CONVEYORS

A wide range of sizes and types in electric vibrating feeders, conveyors, screens, packers, etc. Absolute control over tonnage handled.

M-V MECHANICAL VIBRATING CONVEYORS

For conveying abrasive, lumpy or rough materials, hot or cold, dry or wet, as well as fine materials. Up to 80' can be operated by one drive unit. Also electric vibrating conveyors, feeders, screens and packers.

More detailed information on request.



CRUSHERS—SHREDDERS GRINDERS—PULVERIZERS

BARREL PACKERS

For economy in packing operations—reduce size of container, increase its capacity and cut shipping costs. Also conveyor-type packers and packing tables.

THE JEFFREY MANUFACTURING COMPANY

Established 1877

909 North Fourth St., Columbus 16, Ohio

Complete Line of Material Handling, Processing and Mining Equipment

Baltimore 2	Boston 16	Cincinnati 2	Detroit 13	Jacksonville 2	Philadelphia 3	Salt Lake City 1
Beckley, W. Va.	Buffalo 2	Cleveland 15	Harlan, Ky.	Milwaukee 2	Pittsburgh 22	Scranton 3
Birmingham 3	Chicago 1	Denver 2	Houston 2	New York 7	St. Louis 1	

Jeffrey Mfg. Co. Ltd., Montreal, Canada
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The Galion Iron Works & Mfg. Co., Galion, Ohio
The Kilbourne & Jacobs Mfg. Co., Columbus, Ohio

THE PEERLESS TYPE A *Continuous Duty General Purpose* PUMP

General Characteristics • **SINGLE STAGE HORIZONTAL SPLIT CASE DESIGN**

DOUBLE & SINGLE SUCTION (Double Suction Sizes 1¼" through 48"; Single Suction Sizes 2" & 3")

BOTTOM SUCTION (Bottom Suction Sizes 12" through 42")

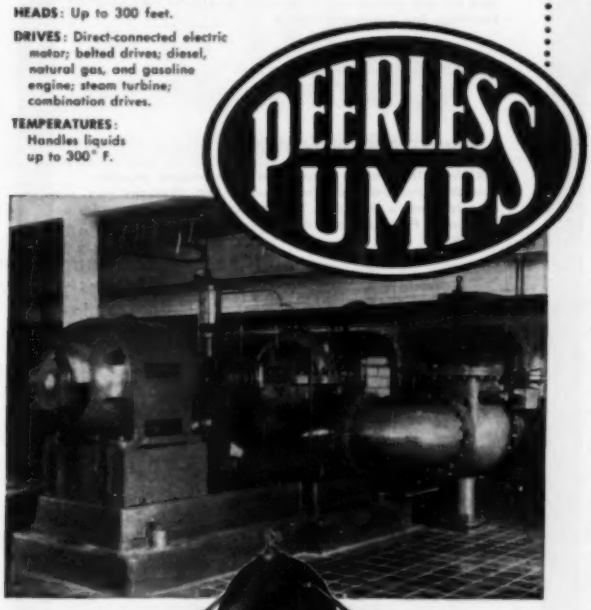
BALL BEARING

CAPACITIES: Up to 70,000 g.p.m.

HEADS: Up to 300 feet.

DRIVES: Direct-connected electric motor; belted drives; diesel, natural gas, and gasoline engine; steam turbine; combination drives.

TEMPERATURES: Handles liquids up to 300° F.



A popular size Type A, viewed from the discharge side. The horizontally split case permits easy access to rotating elements without disturbing pump alignment or piping.

TYPE A *for All purpose pumping*

Peerless Type A pumps can be used in the widest variety of general pumping services, handling clear water and light alkaline fluids, where no solids are in suspension. Applications vary from pumping water for cooling engine jacket water, to providing plant water supply.

TYPE A *for Advanced design*

Peerless Type A pumps are of the ball bearing type with horizontally split casings, for ease of inspection and maintenance. All are furnished with double suction impellers except in three small sizes where single suction design is employed. Bottom suction can be furnished in all sizes from 12" through 42".

TYPE A *for All capacities and heads*

Peerless Type A pumps offer users greatest range in capacities, delivering up to 70,000 g.p.m. Type A characteristics permit pumping against heads up to 300 feet. Liquids of temperatures to 300°F. can be safely handled.

TYPE A *for Ample safety factor*

The mechanical design of the Peerless Type A pump is as superior as its hydraulic characteristics. Oversize shafts, heavy duty ball bearings, modern design wear rings and shaft sleeves all contribute to ample protection against wear, afford a high factor of safety in operation and assure reliable service and extended pump life.

TYPE A *for Accuracy in construction*

Careful attention to every detail of design is evident in the Peerless Type A pump. For example, bearing seats are cast and bored integral with the case, assuring permanent alignment. All parts are machined to gauge on an interchangeable part system and are rigidly inspected in process.

TYPE A *for Added service life*

Every Type A pump is fully tested in Peerless' modern hydraulic testing laboratory, which can duplicate the field conditions under which the pump will be used. Experienced Peerless trained engineers located near you are at the service of pump users, architects, contractors, etc., to see that the Type A pump matches or exceeds expectations.

Write for Bulletin B-1300 describing and illustrating Type A pumps in detail.

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION

Address inquiries to Factories at:
Los Angeles 31, California and Indianapolis 8, Indiana
Offices: New York, Atlanta, Fresno, Los Angeles, Chicago, St. Louis, Phoenix; Dallas, Plainview and Lubbock, Texas; Albuquerque, New Mexico.

4 WAYS TO DE-IRON Materials Carried on Conveyor Belts

DINGS magnets offer a variety of ways to meet problems caused by tramp iron—problems such as fires, explosions, machinery damage or product purification.

One of these ways is the ideal way and its choice is a joint affair—yours and ours. Outline your application to Dings. You can rely on their unbiased recommendation.

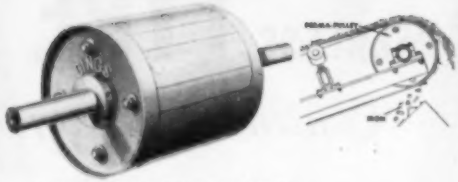
The magnets listed are but part of a complete line of magnetic separators which includes magnets for chutes, ducts, wet applications or fully self contained units. For a description of the complete line . . .

Send For Catalog C-5000 A

In it can be found the answer to any magnetic separation problem.

DINGS MAGNETIC SEPARATOR CO.
4730 W. Electric Avenue, Milwaukee 46, Wis.

Dings



1. DINGS PERMA-PULLEYS

INTENSELY concentrated magnetic strength near the surface makes this the magnet to use where burden depths do not exceed 3". Installed as head drive pulley, tramp iron removal is fully automatic, simple. *Non-electric, permanently energized* it can be installed and forgotten. Catalog C-1007 A gives details.

Powerful, air-cooled electro magnetic pulleys are available for burden depths exceeding 3". Low operating cost, long life and extreme power characterize this work-horse of the Dings line. Catalog C-1001 A.

2. DINGS PERMA-PLATES

PERMA-PLATES are the simplest, most economical magnets available. Installed over the conveyor belt, they are extremely effective on shallow burden depths. *Non-electric and permanent.* Perma-Plates can be made self-cleaning. Catalog C-1205 A.

3. DINGS SUSPENDED RECTANGULARS

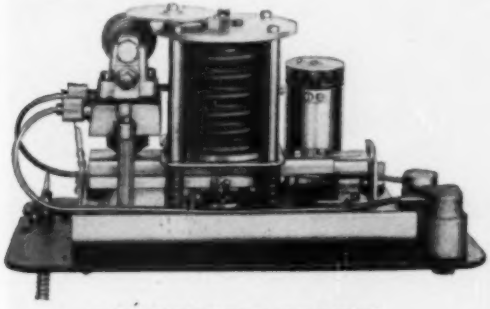
FOR the difficult jobs. Power close and power that searches down 12" to yank tramp iron out. Triple pole, double gap design gives edge to edge protection that can't be surpassed. Install horizontally, vertically or at an angle. Self-cleaning fully automatic models also available. Another model, the DEEP BURDEN Rectangular, is effective at distances to 18". Catalog 301-A.

4. DINGS MAGNETIC DETECTOR

THE Dings Magnetic Detector instantly signals when any magnetic object passes through the detector zone. Can be hooked up to sound an alarm and stop the belt. Ideal where the infrequency of tramp iron does not warrant the use of a magnetic separator, or where heavily loaded, high speed conveyor belts make iron extraction magnetically an impossible task.

DYNAMIC ACCURACY means more today than ever before!

Accurate Measurement of changing temperatures and pressures is the vital first step in instrumentation, whether indicating, recording or controlling. Today, TRANSAIRE* Transmitters set new standards for sensitive and accurate measurement.



TEMPERATURE:

Taylor TRANSAIRE Temperature Transmitter with Speed-Act* lets you measure and transmit smallest temperature changes up to 1000 feet with great accuracy! The *only* temperature transmitter that gives you:

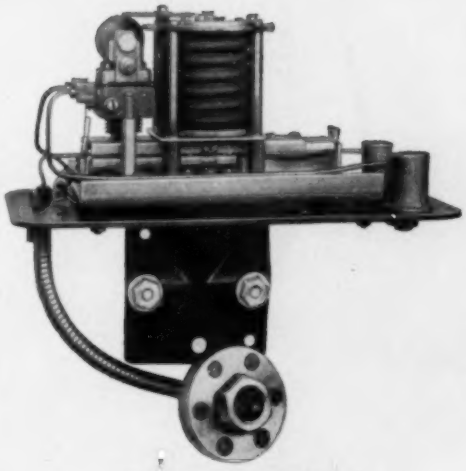
1. DYNAMIC ACCURACY—which means the accuracy of an instrument in measuring changing or dynamic conditions. TRANSAIRE Dynamic Accuracy is unparalleled. Solves the problem of process engineers who realize that an instrument accurate to a fraction of a degree in measuring static conditions can be in error by many degrees when temperature is changing.

2. DYNAMIC COMPENSATION—which means ability to compensate for inherent lags both in measuring system and rate of heat transfer of process medium. TRANSAIRE does this by introducing derivative action (Speed-Act) into *measuring* circuit. The result is Dynamic Accuracy, with a speed of response seldom thought possible, permitting much closer automatic temperature control.

TRANSAIRE is the first step in Taylor's TRANSET* Control System. Step No. 2 is the Taylor TRI-ACT* Controller. Step No. 3 is the Taylor TRANSET Recorder or Indicator. All three combine into the already famous complete Taylor TRANSET Control System. **Write for Bulletin 98097.** Taylor Instrument Companies, Rochester, N.Y., and Toronto, Canada.

*Trade-Mark

Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.



PRESSURE:

Taylor TRANSAIRE Pressure Transmitter with narrow range spans lets you measure and transmit minute pressure changes up to 1000 feet. Works on simple force-balance principle. Accurate to ½% of the selected short range span (*conventional devices are only accurate up to ½% of upper range limit*). Sensitive to pressure changes of ½" water. Here's accuracy and sensitivity never before thought possible in measuring process pressures—plus the convenience of suppressed ranges at high pressure levels.

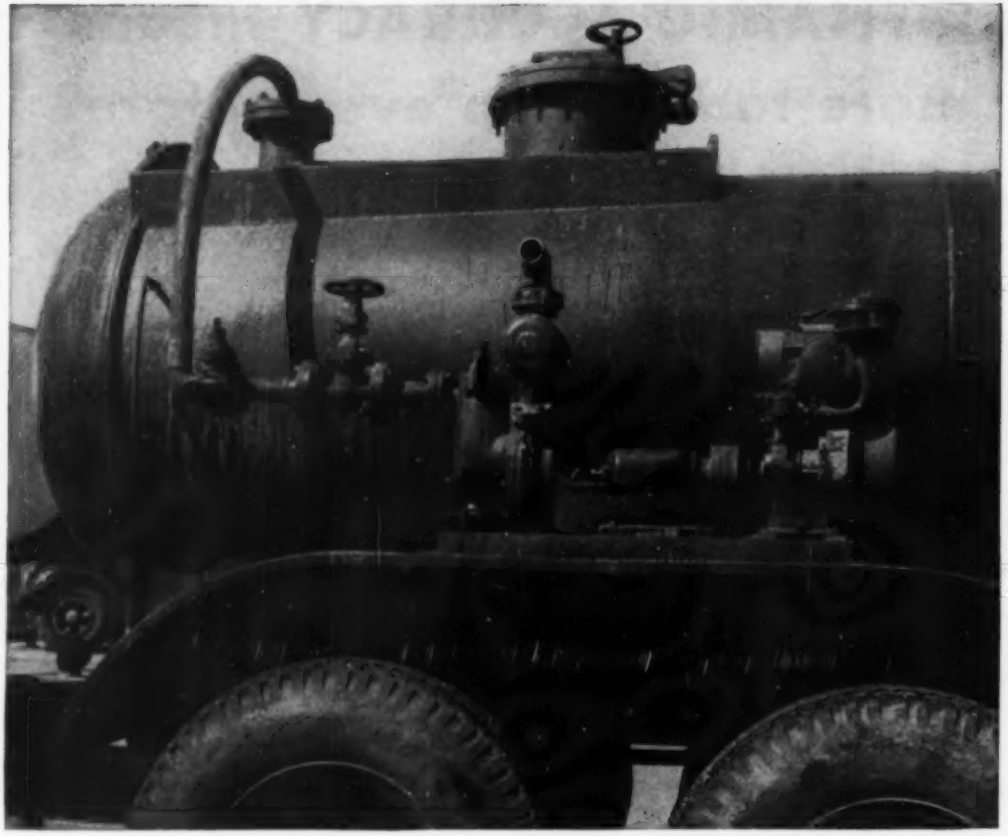
THREE IMPORTANT ADVANTAGES:

1. Range spans of 20 and 40 psi available throughout range limits of 35 to 415 psia.

2. Volumetric type pressure system is extremely accurate, practically clog-proof, has corrosion-resistant 316 stainless steel diaphragm.

3. Temperature and barometric compensation for higher accuracy of measurement and control.

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY



The Tank Outlet that Won't Leak

The self-priming feature of this dependable LaBour DHL type pump makes the usual outlet connection at the bottom of the tank unnecessary. Corrosive liquids may be drawn out by vacuum through the top of the tank. Since absolutely no piping enters the tank below the fluid level, there are no joints or couplings which might develop leaks.

The York Transport Company of Houston, Texas chose LaBour for this application because of LaBour's rapid self-prime action and known dependability.

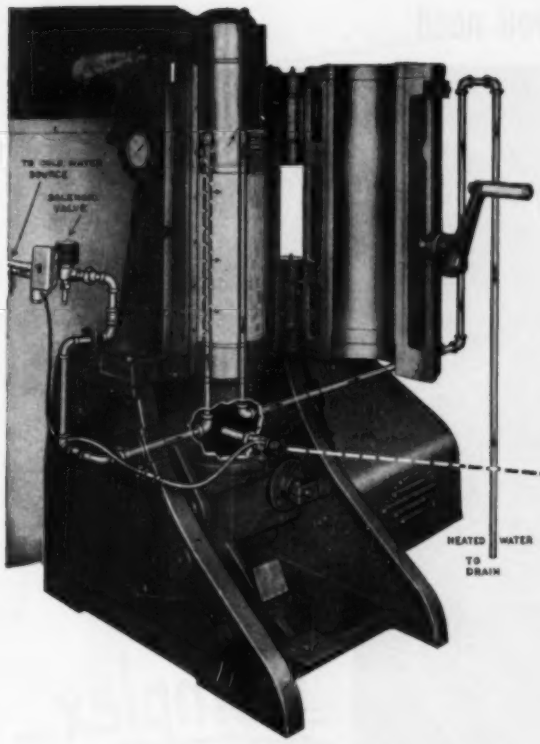
LaBour pumps are recognized throughout the chemical industry for their year-in year-out all-around economical, trouble-free service . . . indoors and out.

This installation is only one of many innovations LaBour has on record. Possibly the solution to your most pressing pump problem is already in our files. Write today.

ORIGINAL MANUFACTURERS OF THE SELF-PRIMING CENTRIFUGAL PUMP

LABOUR

THE LABOUR COMPANY, INC. ★ Elkhart, Indiana, U.S.A.



Multi-purpose THERMOSTAT radically reduces printing plate rejects

CUTAWAY DRAWING shows how Fenwal THERMOSWITCH controls temperature of cooling jacket in the Tubular Plate Caster.

The Tubular Plate Caster machine used in the production of printing plates at the Nordmann Printing Company, 4210 Chippewa St., St. Louis was the seat of considerable trouble when it was water cooled by a hand valve. If too much cold water was run into the cooling jacket, the temperature was reduced so fast that the plates shrank. If too little water entered, the temperature remained too hot and plates became porous. In either case, plates had to be remelted and recast with resultant loss of labor and time.

The problem was solved by replacing the hand valve with a solenoid water valve and installing a low-cost Fenwal THERMOSWITCH thermostat. This unit opens the valve when water gets too hot. Cold water then flows in, hot water drains off, and valve is shut when proper water temperature is reached. *As a result, rejects have been practically eliminated.*

This is but one of many ways in which easy-to-install, easy-to-maintain Fenwal THERMOSWITCH Units effectively control variables where heat is a factor. Their unique principle of operation consists of an activating control element that is a single-metal shell. This shell expands or contracts *instantaneously* with temperature changes, making or breaking the totally enclosed electrical contacts.

Fenwal THERMOSWITCH thermostats can no doubt help you in your own processing. Find out how by mailing the coupon today.

Fenwal

THERMOSWITCH

The Precision Multi-Purpose Thermostatic Control

SENSITIVE . . . but only to heat

FREE! Get this bulletin . . . see what Fenwal THERMOSWITCH units can do for you. *Just fill in coupon and mail . . . no obligation.*

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TEMPERATURE CONTROL ENGINEERS

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- ☐ Heating
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- ☐ Humidity Control or Detection
- ☐ Alarm (over-temperature, under-temperature)
- ☐ Vapor Control
- ☐ Timing (thermal)
- ☐ Radiant Heat Control
- ☐ Pressure Control (by controlling vapor temperature)

OTHER (Please fill in your special requirements) .....
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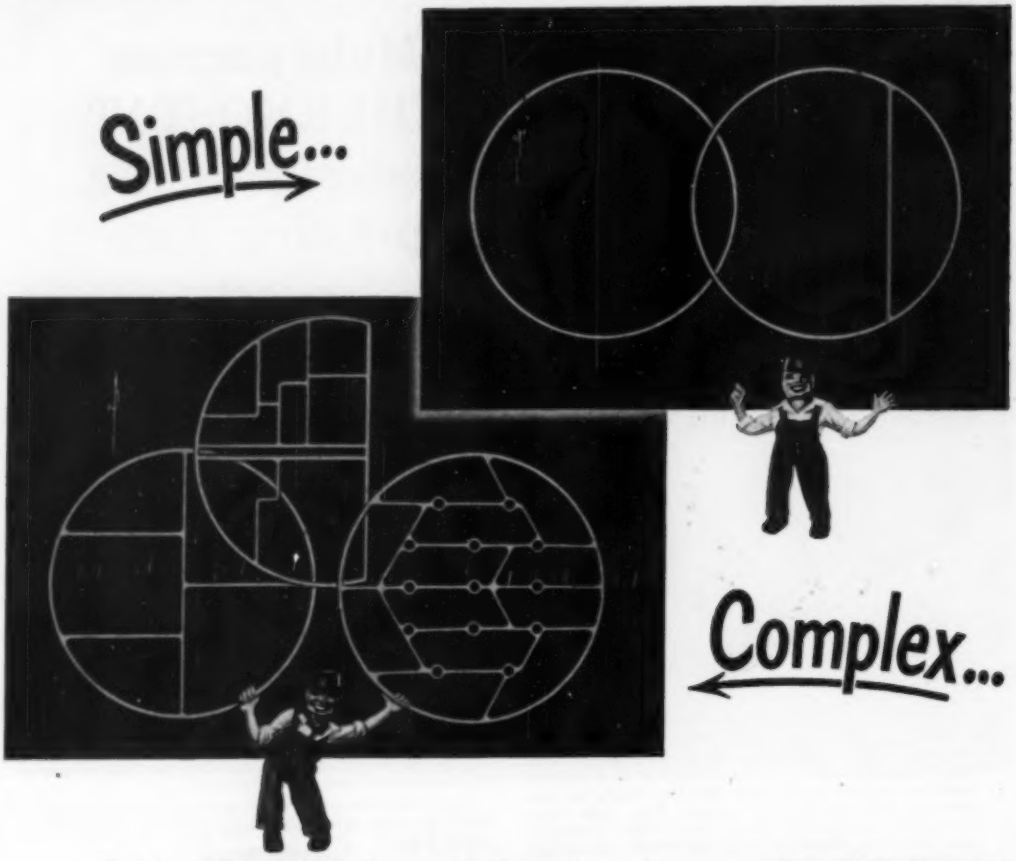
Precision-made to the design you need . . .



Goetze Heat Exchanger Gaskets stay on the job longer!

Whether your specifications call for a simple or complex design, you can depend on Johns-Manville Goetze heat exchanger gaskets to do the kind of sealing job that costs you less in the long run!

That's because they are carefully hand-tailored to assure the accuracy of fit so important in heat exchanger service. Every detail of construction reflects the craftsmanship that goes into the fabrication of these better gaskets. You'll find no wrinkles or cracks on the corners. Lap widths are ample, rib widths uniform.

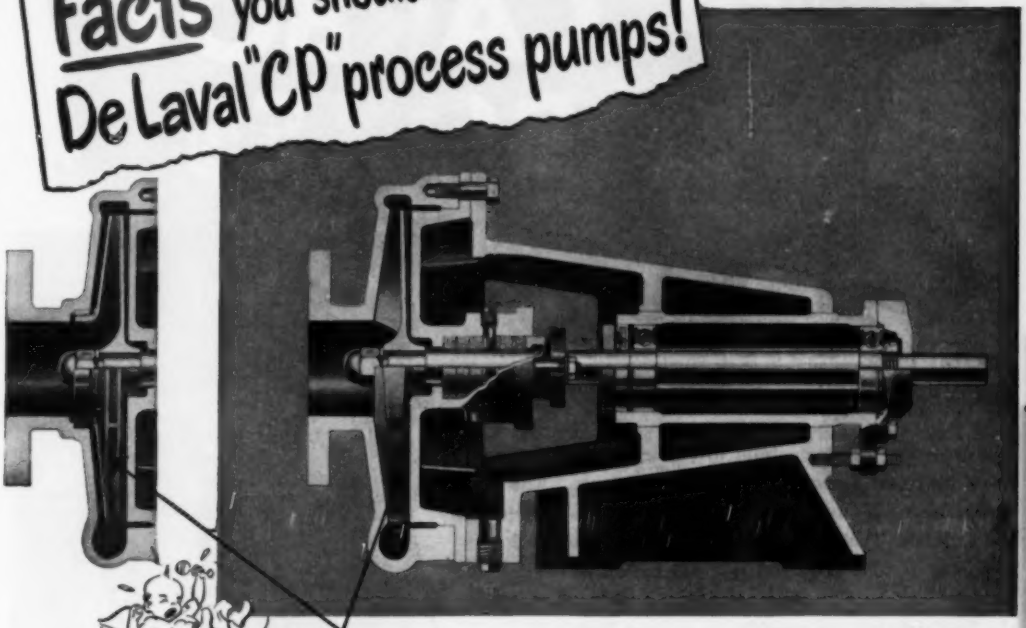
More than 60 years of gasket-making experience is your further assurance that when you put a Goetze heat exchanger gasket on the job, you can count on it to *stay* on the job for a long time. For further details and a prompt estimate of cost, send us a blueprint or template. Just address Johns-Manville, Box 290, New York 16, New York.

JM

Johns-Manville *Goetze* GASKETS

THERE'S A JOHNS-MANVILLE PACKING AND GASKET FOR EVERY SERVICE

Facts you should know about De Laval "CP" process pumps!



When service requirements change, you don't have to buy a whole new pump!

The De Laval CP pump can be quickly converted from closed to open impeller (or vice versa) by changing the pump volute and impeller only. This standardization also means you can keep your stock of spare parts to a minimum. Three sizes of shafts, shaft lock-nuts, bearings, bearing cartridges and pedestals *fit all nine sizes of De Laval CP pumps.*

Did you also know?...

that the external adjusting screw can be used to pull the impeller off the shaft? It is quick, easy and requires no special tools.

Shims and fussy fits are old fashioned...

When you have to compensate for wear between the impeller and case, it is only necessary to face off these parts, reassemble the pump and position the impeller with the external adjusting screw provided for that purpose. No shims required—no fussy fits.

DE LAVAL STEAM TURBINE CO., TRENTON 2, N. J.

TURBINES • HELICAL GEARS • CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

50th DE LAVAL Anniversary

HERCULES CARBOY BOXES

GIVE YOU EXTRA PROTECTION!

PROMPT DELIVERY

You get extra protection from these rugged, all wood carboy boxes due to their sturdy, patented construction . . . with interchangeable cork (Hercules) or rubber cushion (Aero) inserts and cushions. That's why they stand up under the rough-and-tumble of regular usage and save you both time and money by reducing bottle breakage, repairs and replacements. For the best carboy boxes possible . . . contact National!

6½-GALLON CARBOY FEATURES

Built to withstand an internal pressure of 10 lbs. this completely enclosed wooden carboy, with interchangeable cork or rubber cushion inserts and cushions, complies with I.C.C. 1-D regulations for the transportation of mineral acids. Specific application should be made for other uses.

1. Flat cover — no protruding neck—enables boxes to be piled on top of each other for convenient, compact storage.
2. Corner posts provide a convenient handle so that one man can handle the carboy.
3. Small size and light weight provides for easier handling and shipping.
4. Regulation Polystyrene cap supplied.

Complies with classification I.C.C. 1-D

13-GALLON CARBOY FEATURES

1. All-point protection reduces bottle breakage to a minimum—both in loading and transit.
2. Reduces occupational hazards since safety from breakage minimizes danger of acid burns or fire.
3. Eliminates foreign filler materials from container.
4. Easy to handle, through good grip on side hand braces.
5. Compact loading, resulting in space saving storage.
6. No skilled labor or special tools required. Any man can handle it quickly and efficiently.
7. Also available in 5 gallon and other capacities.

Complies with classification I.C.C. 1-A

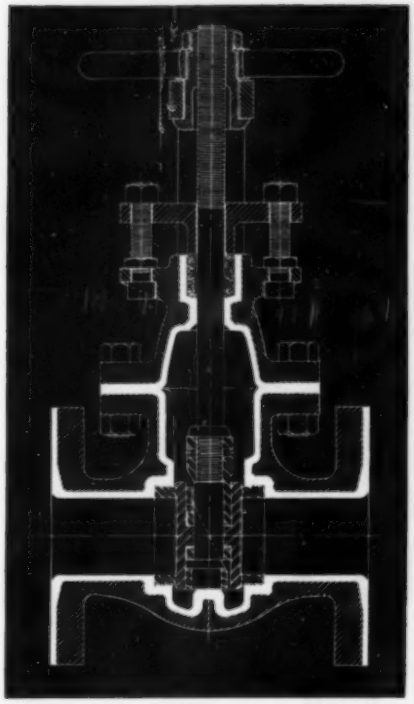
For Information write to Dept. E

NATIONAL BOX & LUMBER COMPANY

NEWARK 5, NEW JERSEY

HANDLING CORROSIVE FLUIDS?

this unique hard rubber lined iron body gate valve offers big savings in many corrosive services . . .



Darling 150-pound rubber lined gate valve, with outside screw and yoke, featuring unique parallel seat, fully revolving disc principle. Plain "no pocket" discs prevent accumulation of sediment. Darling rubber lined gate valves can be furnished only in rising stem, cylinder or motor operated; or quick-opening types.

WHEN Darling gate valves of this type go to work, you gain *multiple* advantages sure to save you money *and* time.

First, you gain big initial savings because these rubber lined iron body gate valves (ideal for many corrosive services not exceeding 180° F.) are much less expensive than special alloy valves. Moreover, Darling's special bonding technique permanently prevents separation of the hard rubber lining from the valve body.

All interior working parts are made of alloys suitable for the corrosive conditions encountered.

Secondly, and equally attractive, is Darling's exclusive *fully revolving double disc, parallel seat* feature! In a nutshell this means drop-tight closure where most other valves would fail. It also assures unmatched life with a very minimum of attention and maintenance.

Here's a combination you just can't beat! Before you buy gate valves of *any* type, get acquainted with these unique Darling valves and their operating details. Get *all* the facts.

Write today for free bulletin describing Darling rubber lined gate and check valves.

DARLING VALVE & Manufacturing Co.
WILLIAMSPORT 3, PA.

DARLING VALVES FOR EVERY NEED

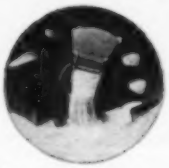
Darling parallel seat revolving disc gate valves are available in a wide range of sizes and constructions for all kinds of normal and unusual service, and for pressures up to 1500 pounds. In addition to rubber lined, iron body valves, corrosion resistant types include plain iron body with special alloy trim, cast steel, all bronze, special alloys or combinations as required. We'll gladly furnish specific recommendations on the proper valves for your particular service.

FOR PLUS VALUES, JOB-PROVED AGAIN AND AGAIN

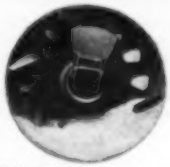
STURTEVANT DUSTLESS BLENDERS

Thoroughly Blend Substances into an Inseparable Mass

The 4-Way Mixing Action of the Sturtevant Dustless Blenders thoroughly mixes two or more substances into an inseparable whole . . . every part of which is the same analysis. Single receiving and discharging opening insures tight sealing during mixing process. "Open-door" accessibility permits thorough cleaning. The fast, accurate mixing operation increases output . . . cuts mixing costs. Available in many sizes with mixing capacities from $\frac{1}{4}$ ton to 75 tons per hour. Write for information and catalog.



Receiving — The ingredients to be mixed enter the mixing chamber of drums through a chute. Note scoops which carry up and dump the ingredients as drum rotates assuring a more uniform mix.

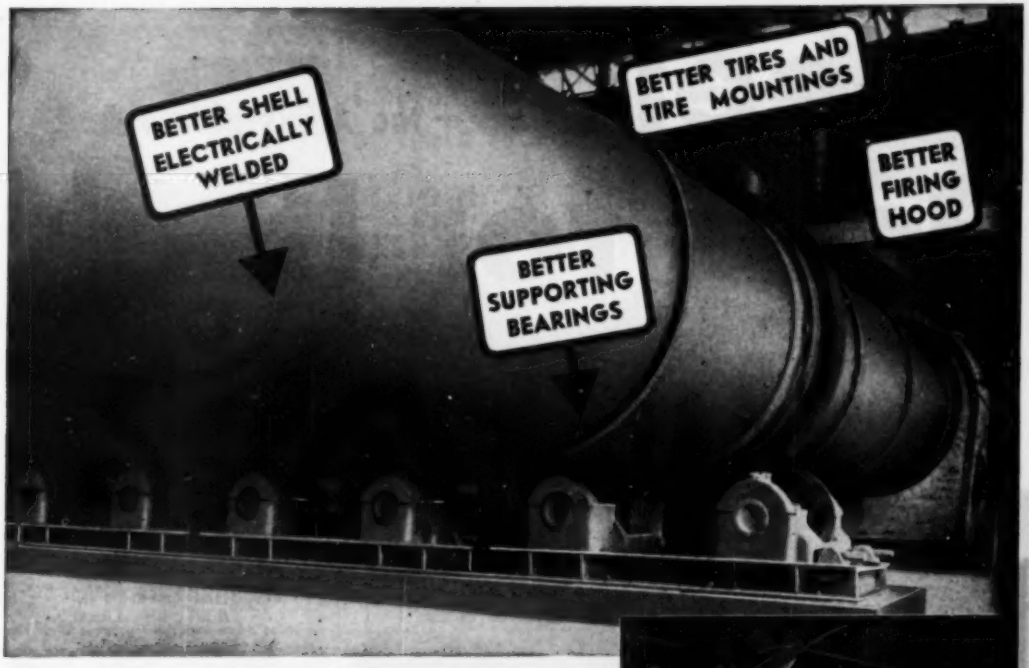


Discharging — Throwing a lever closes the inlet and mixer is in discharging position. The completely mixed materials drop off the lifting scoops and discharge through chute without segregation of ingredients.

The Sturtevant Mill Company

100-A Clayton Street, Boston 22, Massachusetts

Designers and Manufacturers of: CRUSHERS • GRINDERS • SEPARATORS • CONVEYORS • MECHANICAL DENS and EXCAVATORS • ELEVATORS • MIXERS



TROUBLE-FREE OPERATION

is the most important factor in keeping Rotary Kiln Costs down — and profits up. One breakdown can easily offset all of the savings achieved through careful firing and feeding for a long period of time.

That's why every part of every Vulcan Kiln is designed and built with an extra margin of protection against mechanical troubles of any kind and that's why long-time users of Vulcan Rotary Kilns, Coolers, Dryers, Retorts, etc. often order additional units from us without competition. They know that any necessary difference in first cost will be repaid many times over in greater freedom from breakdowns, shutdowns and other operating expense.

This Booklet Tells Why Vulcan Kilns Are Better

and why they give more years of trouble-free service. It's 28 fully-illustrated pages are packed with specific information regarding the design and construction of Vulcan Rotary Kilns, Coolers, Dryers and other related products. No charge or obligation. Write for Bulletin No. A-442. Give name of your company.

The illustrations above show a typical installation of Vulcan Rotary Kilns in a modern cement mill. Note the simple, sturdy design and construction — the entire elimination of any features that might invite mechanical trouble. The improved-type firing hoods were designed for burning pulverized coal but can easily be adapted for burning either gas or oil.

Vulcan Iron Works

Established 1849

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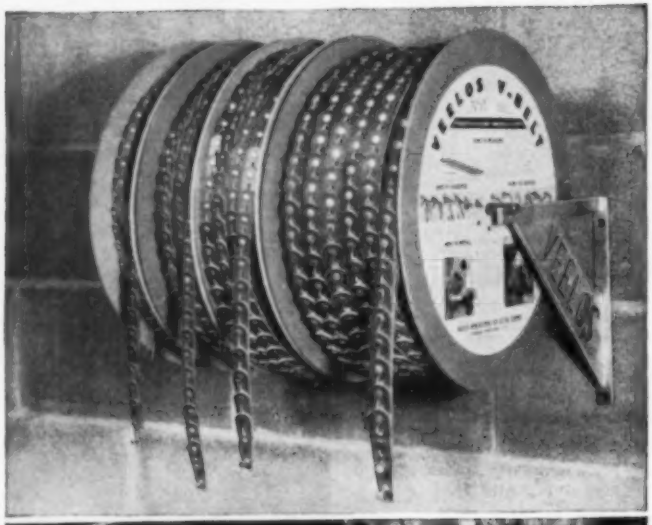
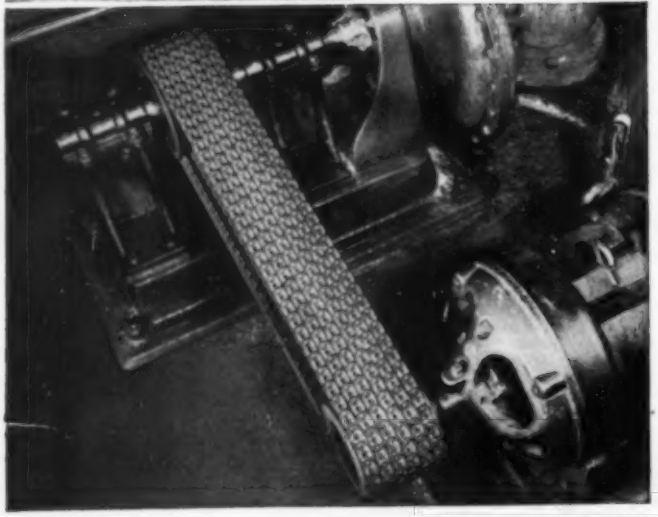
Cable Address "Vulworks Wilkes-Barre"

Other Vulcan Products include Briquetting Machinery, Electric Hoists, Mining Machinery, Open Hearth Steel Castings, Heavy Special Machinery and all types of Industrial Locomotives. Bulletins on request.

Veelos—*the Adjustable V-Belt*
Pays for Itself





In Inventory . . .

Veelos pays for itself by reducing required v-belt stocks. Just 4 reels of Veelos cover *every* v-belt need (up to 316 sizes) in the O, A, B and C widths. Stock only one reel for each width of belt you use—and *any length is readily available.*

In Maintenance . . .

Veelos pays for itself because it can be installed quickly and easily without dismantling outboard bearings or moving motor. Individual belts can be adjusted by simply removing or adding links.

In Operating Efficiency . . .

Veelos pays for itself because uniform tension can be maintained on all belts to provide vibrationless, full power delivery. Simple adjustment of each belt means that *matched sets stay matched.*

Write for your copy of the Veelos Data Book. It gives the complete story on why *Veelos pays for itself.*

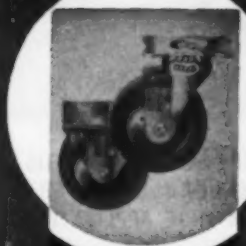
MANHEIM MANUFACTURING & BELTING COMPANY
Manheim, Pennsylvania

VEELOS
THE LINK
V-BELT

ADJUSTABLE TO ANY LENGTH • ADAPTABLE TO ANY DRIVE

Made in all widths in three types; regular, oil-proof and static conducting. Also double V in A and B. Packaged on reels in 100-foot lengths. Sales engineers in principal cities; over 350 distributors throughout the country. Veelos is known as VEELINK outside the United States.

Extra Value



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A special vibration dampener holds the Pyrene pump mechanism firmly in place, protecting it against both vertical and horizontal vibration. And tough brass linings guard the valve housings in every spot where wear would occur. *No other extinguisher offers these vital added construction safeguards.*

In competitive vibrating-machine tests (the most rigorous of such tests known) a Pyrene Vehicle Type Extinguisher outlasted three other major brands by more than 2 to 1 . . . the ratio going as high as 15 to 1. (Chart shows details.) And there is not one single known instance of the Pyrene heavy-duty mechanism wearing out in actual operation.

Lower price doesn't pay when you get half the life! Buy on facts . . . buy Pyrene!

*T.M. Reg. U.S. Pat. Off.

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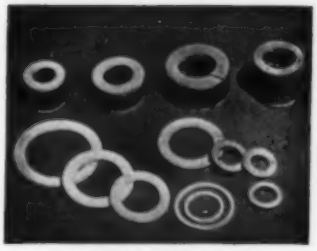
Affiliated with C-O-Two Fire Equipment Co.



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● "Teflon" has the highest degree of chemical inertness of any commercial plastic. It also has zero water absorption and is unaffected by outdoor weathering. The mechanical strength of "Teflon" is high over a wide range of temperatures. Its impact strength is high at temperatures even below minus 90°F and it is capable of continuous service at 500°F.

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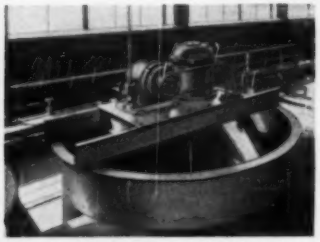

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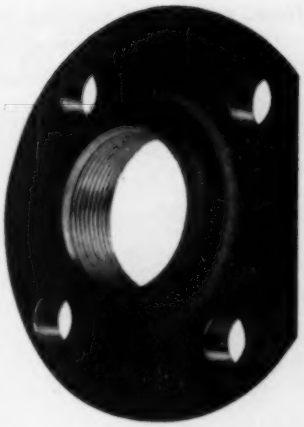

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stainless steel pipe fittings to solve your corrosion problems

All screwed Caps, Couplings, Plugs, Bushings and Unions up to and including 2" I.P.S. are machined from solid bar stock.

These fittings — sold at same price as competing 150 lb. cast fittings — can be used where working pressures of up to 1000 lbs. are experienced.

These stainless steel fittings are available in Types 304, 316 and 347.

Write TODAY for the 1951 Camco catalog and price schedules!

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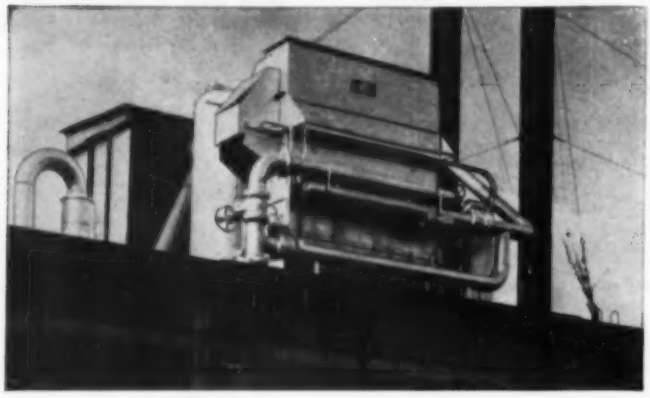
Direct saving of cooling water expense returns to you the cost of a Niagara Aero After Cooler in less than two years.



How to Get Drier Compressed Air:

It prevents many troubles and saves much expense

● NIAGARA AERO AFTER COOLER cools compressed air or gas below the temperature of the surrounding atmosphere. Therefore you get no further condensation in your lines. You save much in repairs to pneumatic tools and equipment; you save much interruption to production; you save water damage in paint spraying, in air cleaning, in any process where compressed air comes in contact with your materials or parts in manufacturing (sand blasting, for example).

Niagara Aero After Cooler uses evaporative cooling, saving 95% of your cooling water consumption. This saving quickly returns the cost of the equipment to the owner or makes extra cooling water available for other processes.

The Niagara Aero After Cooler produces compressed air with 30% to 50% less moisture than by ordinary cooling methods. Other Niagara equipment provides bone-dry air for processes requiring it.

If you have an air problem or a cooling problem, a Niagara engineer probably has an answer that will improve your process or save you operating or maintenance expense.

Write for Bulletin 98

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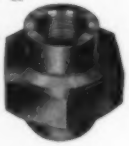

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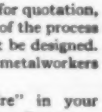

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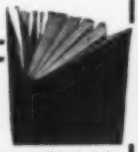

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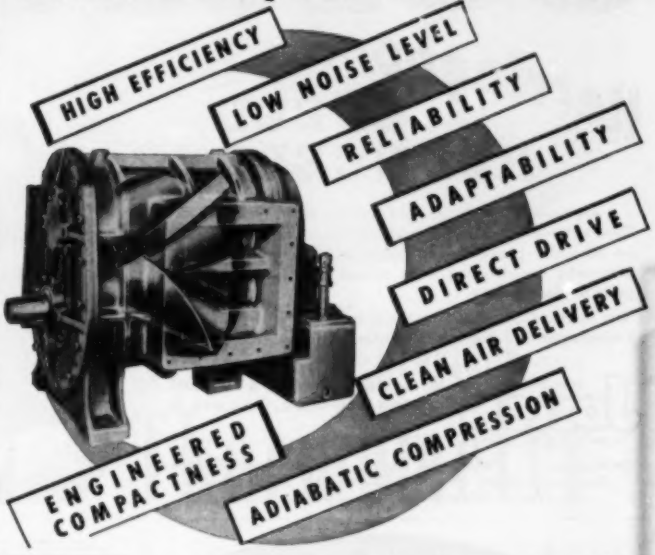

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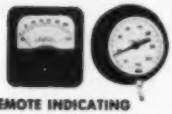

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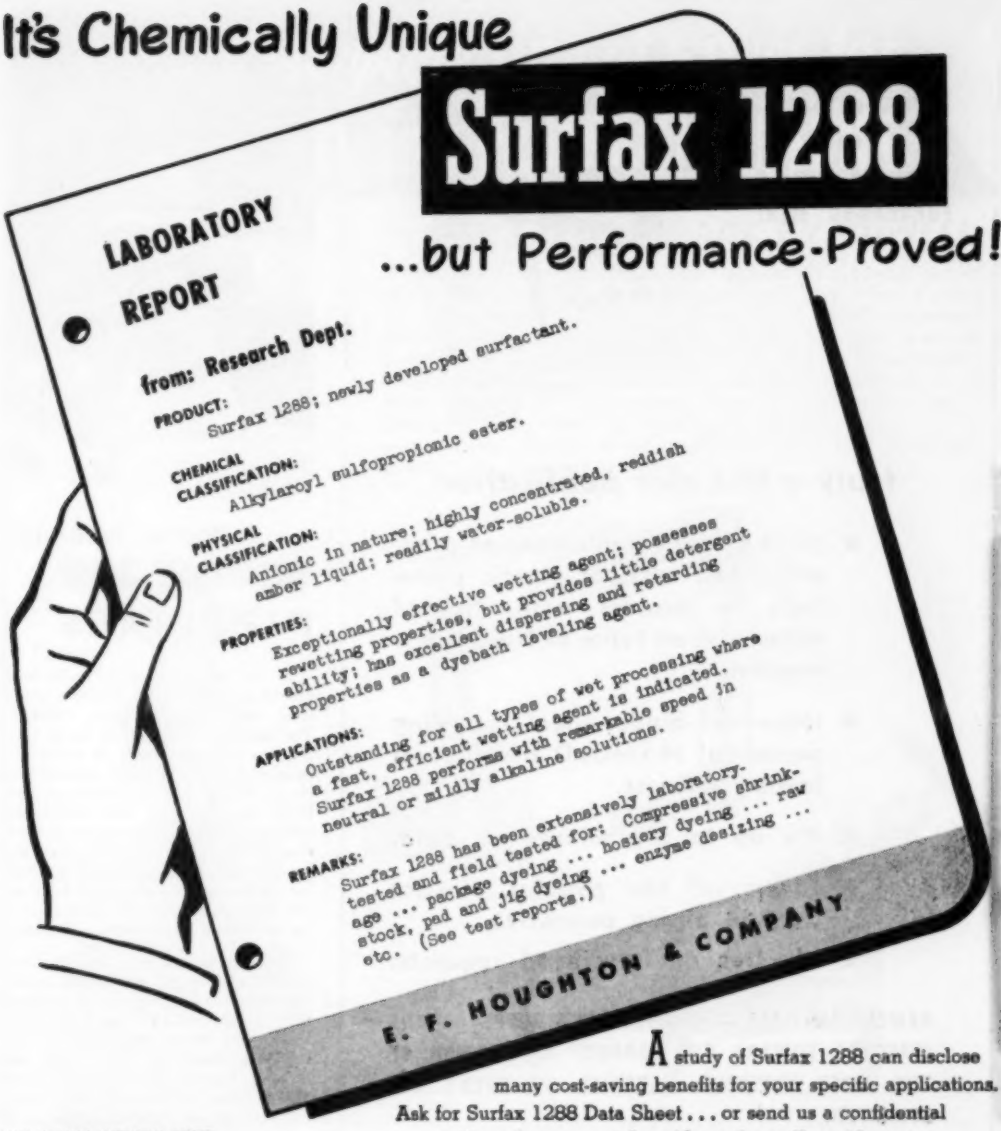
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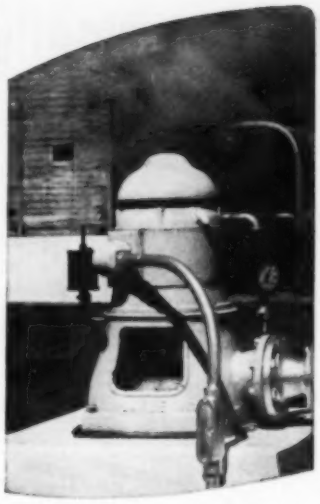

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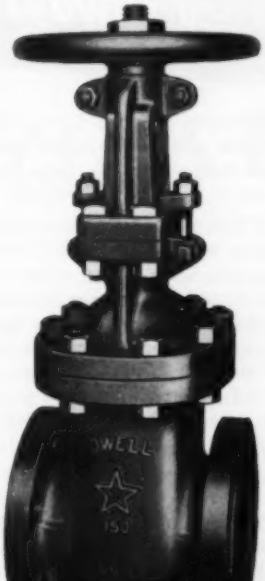

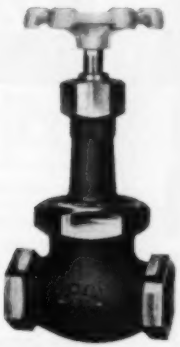

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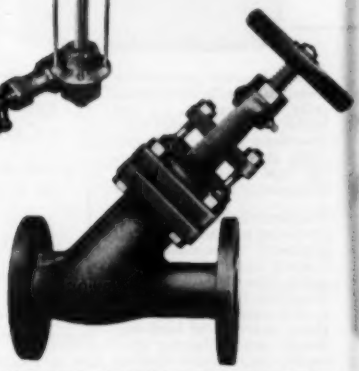

Fig. 1903 S.S. — Class 150 - pound Stainless Steel Gate Valve with outside screw rising stem, bolted flanged yoke, tapered solid wedge. Available in various other corrosion-resisting metals and alloys. Flange dimensions and wall sections conform to ASA B16e Standard.

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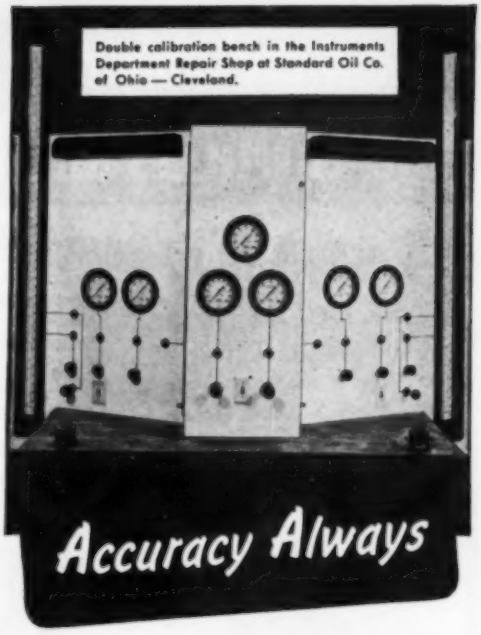

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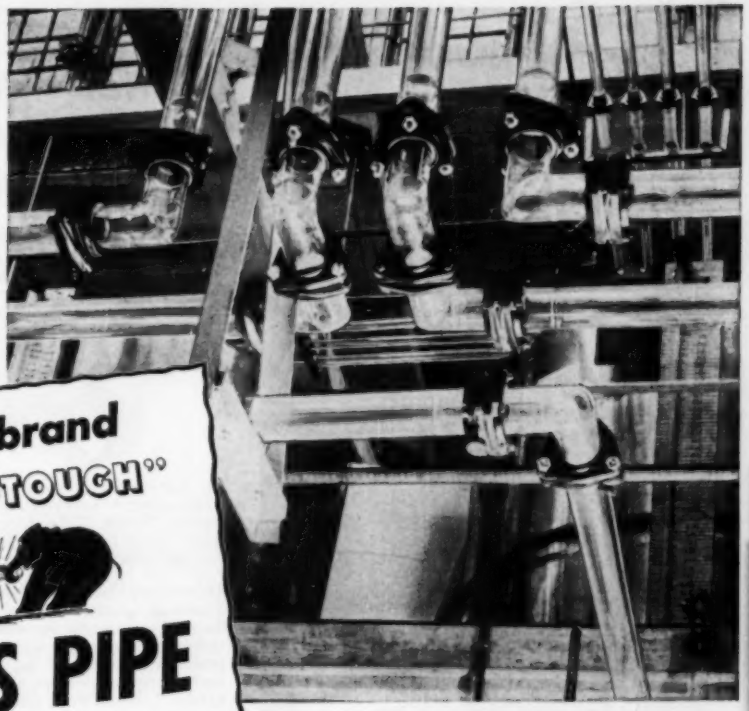

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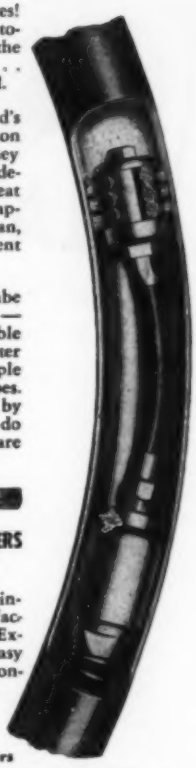

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Use them to re-roll old tubes or install new ones. Precision-manufactured Wilson-Dudgeon Tube Expanders insure solid seating, easy rolling. All sizes, in flaring and non-flaring types, available

WRITE FOR BULLETIN 47A
on Tube Cleaners
and Bulletin 380 on Tube Expanders

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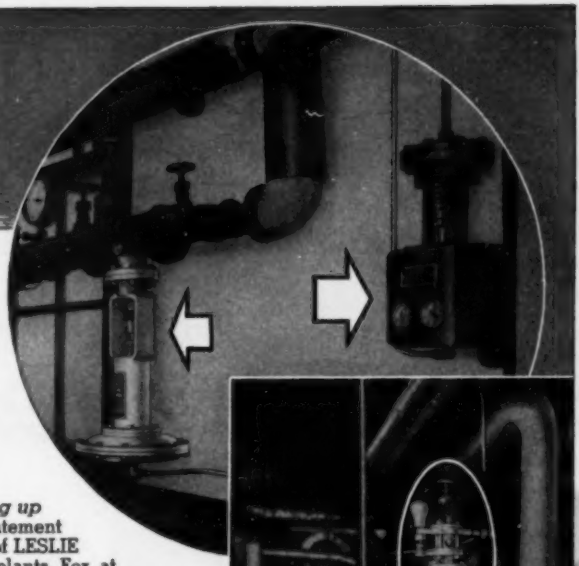
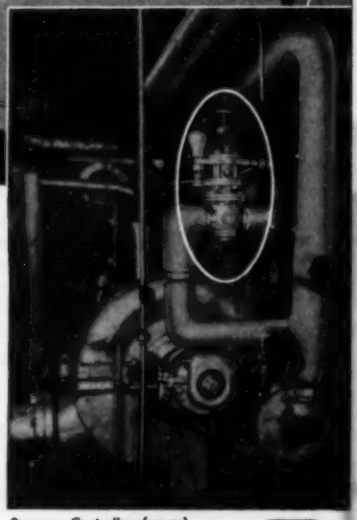
. . . used at American Cyanamid plants for their "very little maintenance"





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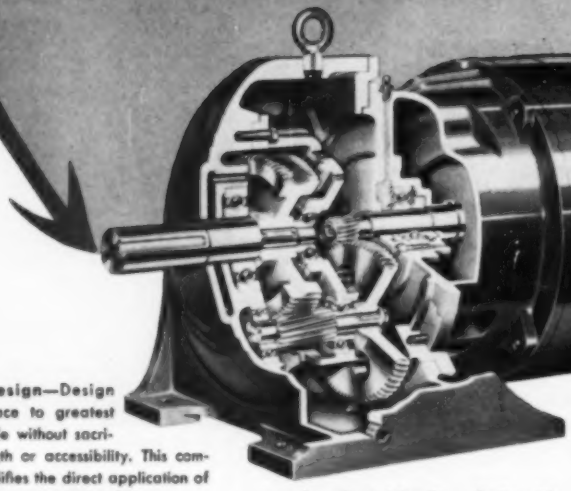

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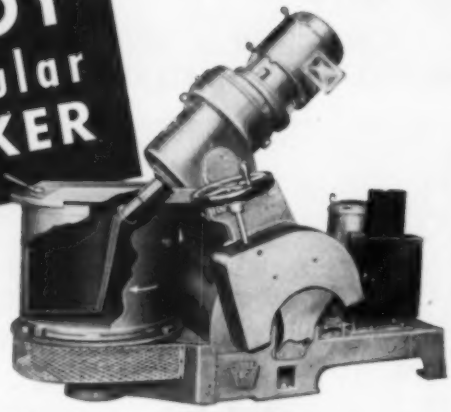
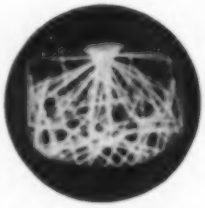
Angular
MIXER



Something Different in Mixing Action!

. . . an action that may give you the better mixing you must have



Effect produced by repetitive photographs of model of the mixer arranged to combine whirling action of the mixing arm with rotation of can. Note how thoroughly the entire space occupied by the batch is covered by the agitator.

Combine the unique folding-in action of the angular mixing arm with the rotational movement of the change can and its contents and you get unusual mixing action. One section of the arm, as it rotates, passes close to the bottom driving the materials to the top and when it reaches the top forces material downward again. Another section of the mixing arm sweeps the sides of the can with a rotational movement. The third section cuts through the charge in the can, with an eccentric like motion. While all this is going on, the can itself is rotating on the power driven turntable, resulting in the elimination of any dead spots or localized whirlpools. Tests and production results on many different products bear out this point. Mixing is thorough and fast.

The Troy Angular Mixer is available in two production sizes: 40 and 60 gallons. Several sizes of motors are available, the selection depending upon the nature of materials being mixed: light motors for liquids and semi-pastes; larger up to very heavy motors for heavy and extremely viscous materials. The design is such that when mixing is completed, the whole mixing mechanism can be tilted back to permit removal of the can.

TROY

Process Machinery Division

TROY ENGINE & MACHINE CO.

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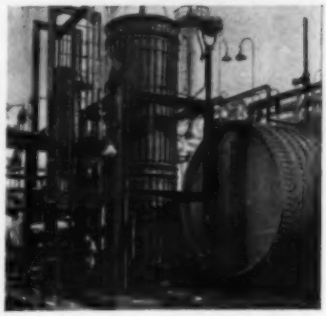
This Program Gives You

PERMANENT PROTECTION

Against Corrosion



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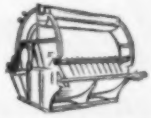
31-A



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and various free-flowing substances used in the chemical processing industries

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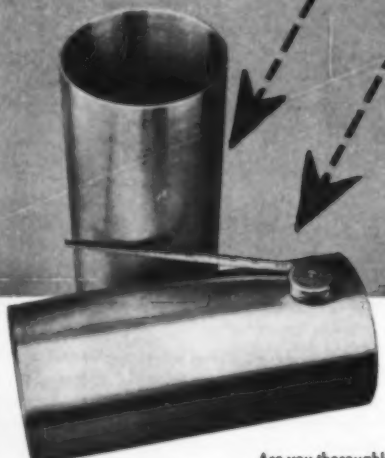

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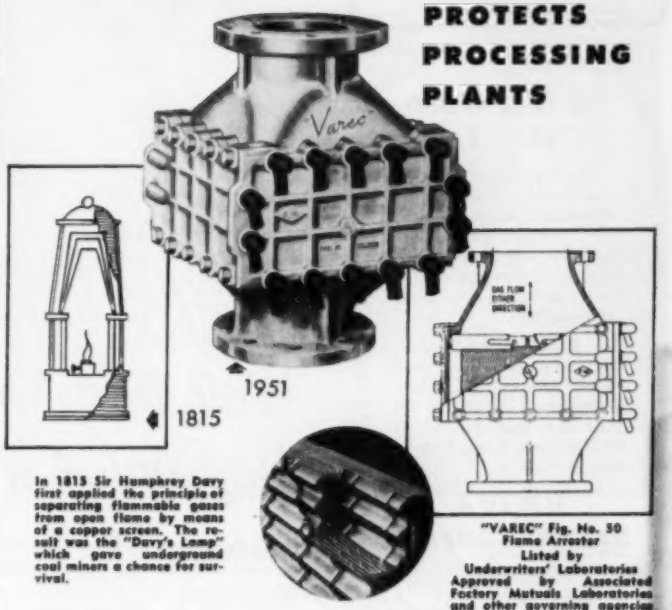

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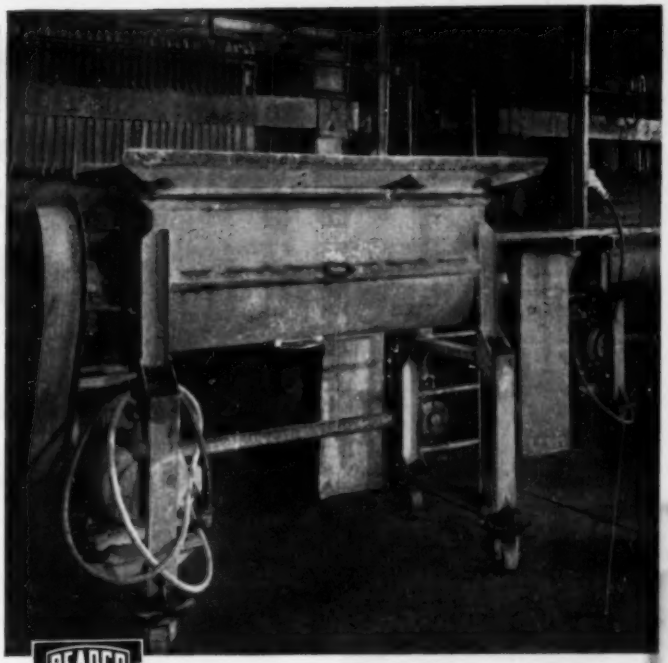

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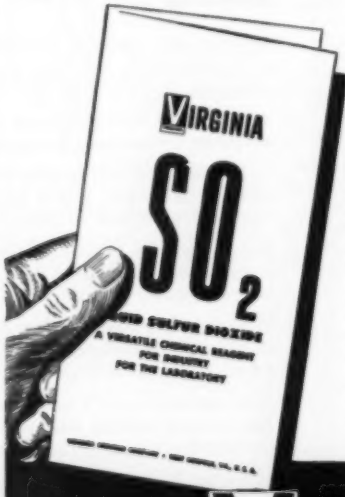

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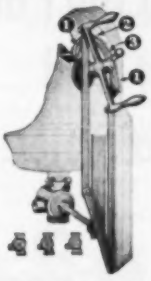

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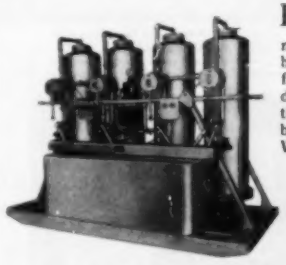

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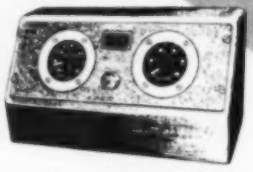

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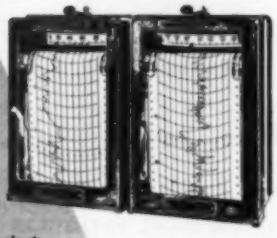

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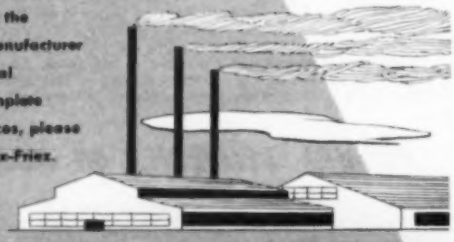

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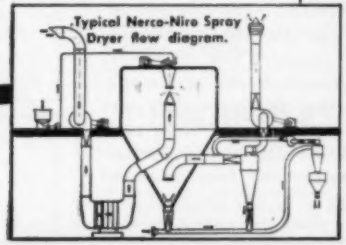

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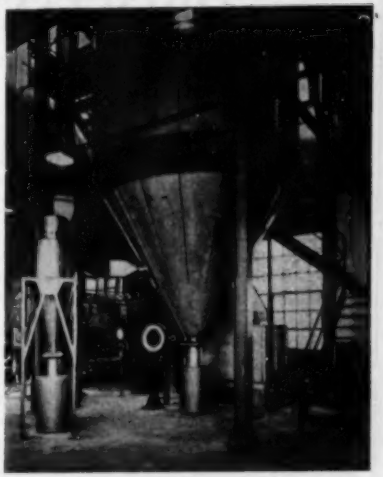

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Positions available for Chemical Engineers with minimum 10 years' experience in the alumina reduction or alumina industry. Experience and ability in the construction and maintenance of electrolytic cells and alumina processing also desirable. Furnish detailed resume of experiences stating salary required.

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Torrance, California

Additional Employment Advertising on page 446

POSITIONS WANTED
(Continued from page 445)

AMBITIOUS YOUNG man seeks any position with a promising future. B.S. in Chem. June 1951, married, veteran, age 28. Will go anywhere but the Atlantic seaboard is preferred. PW-9465, Chemical Engineering.

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ANYTHING within reason that is wanted in the field served by Chemical Engineering can be quickly located through bringing it to the attention of thousands of men whose interest is assured because this is the business paper they read.

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Top flight junior executive with 14 yrs. sound diversified experience including chemical plant operation, process and process equipment development, sales development and high level selling of heavy process equipment and complete processes. Experience in Washington. A record of accomplishment which reflects sound judgment, ingenuity, drive and an excellent personality. Intimately acquainted with industry, both domestic and foreign. Administrative ability for management or assistant to executive. Located in East, prefer Gulf or West Coast.

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Chemical engineer, experienced in production, research consulting and personnel management. Desires managerial post in company training programs, supervisory or advisory capacity in production or development in a chemical industry. PW 9590 Chemical Engineering, 330 W. 42nd St., New York 18, N. Y.

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Manufacturers Agent covering Eastern Pennsylvania, Southern New Jersey and Delaware, contacting chemical, refinery, and other industrial plants can handle an additional account.

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Soda Ash—Caustic Soda, etc.
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THE
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One 1200 gal. Copper Vacuum Pan, manufacturer Joseph Oat & Sons, Philadelphia, Pa.
One Filter Press, Type DO, manufacturer T. Shriver & Co., Harrison, N. J.
One #6 Super Centrifuge, manufacturer Sharples Specialty Co., Philadelphia, Pa.
All in excellent condition.
Contact
G. BRUNING TOBACCO EXTRACT CO., INC.
LYNCHBURG, VA.

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CHEMICAL PLANT

Large financially powerful diversified organization wishes to add another enterprise to present holdings

CASH PAID
For Capital Stock or Assets Existing Personnel Normally Retained

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Compressors Wanted
STATIONARY - PORTABLE
LARGE OR SMALL
L. W. BAUER
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WANTED
Single Drum Type
DRYER
W-9488, Chemical Engineering
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"Swenson-Walker", 40'—0" long (10'—0" sections), continuous, steel & cast iron construction; deck plate curves; complete with reduction units; mounted on steel supports. Insulated.

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One battery of Two, 40", bronze baskets, bottom discharge, suspended type, 5 HP, 720 RPM vertical motors direct connected. Hand operated unloaders. Mounted in steel framework.

AGITATORS

Two with 8'—0" dia x 7'—0" vert. tanks
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Fractionators—Pressure Drums, Furnaces—Air Compressors—Pumps—Vessels—Exchangers—Instruments

For Complete Inventory
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2—Cottrell Electrical Precipitators of two Units each having rated capacity of normal gas 100,000 c.f.m. Electrical equipment for 440 Volt, 3 Phase, 60 Cycle power.

Complete description sent upon request.

Also miscellaneous milling equipment and motors of various sizes.

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DAY MOGUL MIXER
100—Gal.—Type MDC—Class 6
Jacketed Tank
FINE CONDITION
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FOR SALE
Reconditioned 100 gallon steam-jacketed Baker-Perkins Mixer BB type with Sigma blades.

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Sweetland Filter #5, 24" dia., 20-plate, 185 sq. ft; Sweetland Filter #3, 24" dia., 20-plate, 185 sq. ft; Sweetland Model EK 23 x 23, 100-plate, filter plates of coated aluminum, can be used for water, wine, beer, or similar.

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American St. and Susquehanna Ave., Phila., Pa.

A "BRILL BUY" *is the Best Buy*

CENTRIFUGALS
Motor Driven

3—AT&M 60" centersling, S.S.

2—AT&M 48" Suspended, steel.

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1—Roberts 30" Suspended, perforated, steel.

2—Tolhurst 20", rubber-covered.

2—Bird 36"x30", solid bowl, Continuous, rubber covered.

2—Bird 36"x30", 24"x38", solid bowl, Continuous, steel.

1—Baker Perkins 48" "Tor-Maer" Continuous.

3—Sharples #6, steel.

1—Sharples Misco Separator, S.S., 3 HP motor.

FILTERS

2—Oliver monel 9'x10' Rotary Vac.

2—Vallez #40 Pressure Filters, 31 leaves.

3—Sweetland #12 Filters, 72 bronze leaves.

1—Sweetland #10 with 26 steel leaves, 4" centers.

1—Sweetland #2 stainless steel, 12 leaves.

7—Oliver Rotary 11'6"x18', 8'x12', 8'x8', 5'4"x8', 3'x4', 1'x1'.

1—Swenson Rotary 4'x5'.

2—Shriver 30"x30" Recessed, 55 chambers.

4—Shriver 30"x30" P&F, 30 chambers.

1—Sperry Aluminum 30"x30" P&F, 28 chambers, with hydraulic closure.

1—Shriver 18"x18" P&F, 15 C.I. chambers.

2—Sperry Type, 20"x20", recessed, 25 C.I. chambers.

1—Sperry 24"x24" bronze P&F, 22 chambers.

1—Shriver 12"x12" P&F, 13 chambers.

10—Shriver Skeletons, 18" to 42".

PULVERIZERS

2—Bauer 38" Attrition Mills, each with 2-50HP motors.

1—Raymond #45 Imp Mill.

1—Patterson 8'x16' Manganese Jacketed Ball Mill.

1—Abbe 5'x8' Manganese Jacketed Ball Mill.

3—Abbe 8'x8', 36"x42", 32"x36" Pebble Mills.

6—Patterson 4'x5', 3'x4' Pebble Mills.

1—Mikro Pulverizer #1SH.

5—Colloid Mills 8" and 4" dia., S.S.

1—Williams 20"x18" Hammer Mill.

1—Jeffrey 20"x12" Type B Hammer Mill.

6—Hardinge Mills, 10"x36", 8"x22", 6"x22", 5"x36", 5"x22", 4½"x16".

3—Day 16"x40", 12"x30", 9"x24", 3-Roll Mills.

3—Raymond 8', 6' and 4' Air Separators.

1—Simpson Intensive Mixer #1½.

1—Ball & Jewell #1½ Rotary Cutter.

SCREENS

8—Rotex Screens 40"x84", 40"x120", 60"x 120".

1—Robinson 40"x84" Stainless Single Deck.

10—Tyler Hum...er 3'x5' Triple Deck.

KETTLES

8—2500 gal. steel jacketed agitated Kettles, 200# psi.

10—Stainless 20 to 300 gal., jacketed.

1—3200-gal. Horizontal rubber-lined Tank.

2—Buflovak 8' dia. Crystallisers.

1—2'x15' Jacketed Crystalliser.

25—Pfaudler Sectional glass-lined Tanks, 7500 gal., 8250 gal.

2—200 gal. glass lined jkt'd. Agitated Kettle.

1—Stainless Steel Tank, Hor., 2300 gal.

1—Patterson 150 gal. jkt'd. Autoclave, 300# pressure.

SPECIAL OFFERINGS

1—**Pfaudler 750 gal. glass-lined jacketed Reactor.**

1—**Glascote 750 gal. open top jacketed glass-lined Kettle.**

1—**Mojonnier double effect S.S. Evaporator 180 sq. ft.**

6—**2000 gal. steel, jacketed, agitated Kettles, 200# pressure.**

1—**Link Belt 5'x20' Roto-Louvre Dryer.**

1—**Link Belt 2'7"x8' Roto-Louvre Dryer, monel.**

2—**11'6"x18' Oliver Rotary Vac. Filters.**

1—**12500 gal. Hor. 10'x21'6"x 1" Pressure Tank.**

2—**10000 gal. Hor. welded steel Pressure Tanks, 8'x27'x31/32", ASME Code, 225 psi.**

2—**8200 gal. Hor. Steel Pressure Tanks 70"x40'x2" for 390 psi.**

5—**3500 gal. Hor. Steel Pressure Tanks 5'x23'x⅜" for 300 psi.**

1—**Fuller C-30 Compressor.**

1—**16000 gal. Vert. Steel Tank 10'6"x25'x¼".**

1—**16900 gal. Hor. Steel Tank 9'6"x32'x9/32".**

MIXERS—ALL TYPES

3—Baker-Perkins 30, 9, ½-gal., steam jacketed, Double Arm.

1—Baker-Perkins 2 gal. S.S. Double Arm.

1—Howes 2000# Horiz. Powder Mixer.

10—Day, Robinson 100# to 2000# Powder.

25—Electric Portable Agitators ¼ HP to 5 HP.

2—Ross, Porter 40 and 50 gal. Pony Mixers.

9—Day Wall Mixers, 150 gal.

1—Simpson Intensive Mixers #1½.

ROTARY VACUUM FILTERS

2—**Oliver 8'x10' monel Rotary Vacuum Filters with monel valves, rubber-covered trough, agitator & repulper, complete with receivers, drives & motors.**

4—**Eimco 3'x1' Rotary Vacuum Filters 316 S.S. construction, complete with agitator and repulper, drives and motors.**

FULL DETAILS ON REQUEST

WIRE—PHONE—WRITE

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1—Link Belt, 5'x20' Roto-Louvre Dryer.

1—Link Belt 2'7"x8' monel Roto-Louvre Dryer with steam coil heating unit.

2—Vulcan 9'x125' Kilns, ¾" shell.

1—Ruggles Coles Style XB10 Rotary Dryer 70"x40'.

1—Ruggles-Coles 4'x20' Indirect Heat Rotary Dryer.

1—8'x48' Rotary Dryer with ⅝" steel shell.

4—Louisville Rotary Steam Tube Dryers 6'x50', 6'x25', 30"x20'.

1—Adt, 5'x35' Rotary Steam Tube Dryer.

DRYERS
VACUUM and ATMOSPHERIC

4—Stokes & Buffalo Rotary Vac. Dryers 18"x42", 30"x8', 3'x15', 5'x30'.

1—Stokes Vacuum Shelf Dryer, 6 shelves, 42"x42".

1—P&S Conveyor Dryer, 9' wide x 52' long.

5—Atmospheric Double Drum Dryers, 42"x 120", 32"x100", 32"x30", 36"x84".

5—Single Drum Atmospheric, 5'x12', 4'x9', 4'x6'.

3—Devine 5'x12' Vacuum Drum.

MISCELLANEOUS

7—Stokes Vacuum Pumps, 15 to 100 CFM.

1—Milton Roy Proportioneer Pump, S. S. and Hastelloy, 10 gpm.

2—Worthington Vacuum Pumps 800 cfm.

9—Stokes Tablet Machines, ⅛" to 2½".

1—#1 Anderson Expeller.

4—Hank Hytor Vacuum Pumps to 300 cfm.

5—Rodgers, Stokes & Smith Powder Fillers.

1—Knapp #428 Automatic Carton Sealer.

20—Belt, Screw & Bucket Conveyors.

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BRILL EQUIPMENT COMPANY

2401 Third Ave., New York 51, N.Y.

Tel. Cypress 2-5703

FOR SALE

1 Hardinge Conical Ball Mill, Steel Liner, 4'6" dia. x 24" long, complete.

3 Sprout Waldron Attrition Mills, double disc—sizes 10 and 30.

1 Williams Hammer Mill, type AK; size A, stainless steel.

6 Mikro Pulverizers—#4TH, #3TH, #3SI, #1F, Bantam SH.

1 Fitzpatrick model D Comminuting Mach. —Stainless.

4 VALLEZ Rotating Leaf Pressure Filters, type 49RS, 41 leaves 44½" OD on 3" centers, cast iron body, stainless steel covered leaves. Used only 6 months.

2 Sweetland Filters—#2 and #5.

1 Swenson Rotary Continuous Vacuum Filter: Precoat type, 9' dia. x 8' face, rubber covered and lead acid proof construction.

1 Shriver 30" C.I. Recessed Plate Filter Press, 35 plates, open delivery.

1 Shriver 24" C.I. P&F Filter Press, 30 ch., closed delv.

6 Filter Presses, 12" to 24".

2 Louisville 6-roll Continuous Grains Presses, 24" and 36".

1 Davenport Rotary Grains Press, size 2A.

1 Vacuum Pan Dryer or Graining Kettle, 10' dia. x 3' deep.

2 Pan Dryers or Graining Kettles, 10' dia. x 3' deep and 5' dia. x 30" deep.

1 Stokes #59A Vacuum Rotary Dryer, 18" dia. x 42" long, with pump and condenser.

2 Atm. Double Drum Dryers, 22" x 36".

1 Atm. Tray Dryer, 1080 sq. ft.

LIQUIDATING EQUIPMENT
Former ALCOHOL PLANT

Capacity 1200 W.G. of 190 proof alcohol per day.

DISTILLATION EQUIPMENT
COOKING EQUIPMENT
YEAST EQUIPMENT
TANKS, PUMPS, ETC.

Write for list.

1 Porter heavy duty jacketed double worm mixer—75 gal.

2 Read heavy duty double arm jacketed mixers, 200 gal. working cap.—1 stainless lined.

2 Read horiz. jacketed Ribbon Mixers, 80 gal.

1 Robinson horiz. Ribbon Mixer, 5000#.

1 Broughton Powder Mixer, double arm, 2400#.

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2 Kux Mach. Co. Model 25 Rotary Pellet Presses, 21 & 25 punch—with motor and vari-drive.

9 Stokes RD-3 & RD-4 Rotary Pellet Presses, 16 punch.

1 Byron Jackson Deep Well Pump, 150 GPM—325' head, NEW.

1 Ingersoll Rand Bronze Centrifugal Pump #5ALV, 40 HP motor, 850 GPM at 140'—NEW.

2 Ingersoll Rand Bronze Centrifugal Pumps, #1½-RVH, 20 HP motor, 200 GPM at 230'.

STAINLESS STEEL KETTLES

20# Jacket—Vertical Agitators
3—2700 gal. cap. 7'6" dia. x 7'6" high.
3— 950 gal. cap. 63" dia. x 78" high.
Type 347 stainless steel shell; cast iron top.

70 Stainless Steel and Stainless Clad open top, steam jacketed kettles—20, 30, 40, 60, 80, 100, 150, 200 gal. sizes.

6 Stainless Steel, type 316, closed tanks—50, 80 & 300 gal. sizes.

20 Stainless Steel, type 304, open top tanks—6, 15, 30, 50, 60, 100, 150, 200, 300, 500 gal. sizes.

1 Stainless Steel, type 347 Autoclave or pressure tank; 350# pr. 850° F; 100 gal. cap., 17¼" dia. x 9' high.

3 Monel Tanks, 69 gal. bolted top, coils.

15 Glass lined Steel Tanks, horiz., 7500 gal. & 8250 gal.—Brewery lining.

1 Dopp Cast Iron 300 gal. kettle, jacketed & agitated, open top.

1 Steel Autoclave, 130 gal., 23" dia. x 74" deep, 125# int. pr., 15# jkt. pr.

3 Steel Autoclaves, 50 gal., 23" dia. x 30" deep, 300# int. pr., 100# jkt. pr., agitated.

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STAINLESS STEEL VACUUM PANS
—jacketed and with coils
1—150 gal. work. cap.
1—300 gal. work. cap.
excellent condition.

2 Copper Vacuum Kettles, 100 gal., 48" dia., jacketed, agitated.

1 Copper Vacuum Evaporating Pan, 6' dia.—jacketed and coils.

1 Steel Still Pot, 300° gal., with coils.

1 Struthers Wells Evaporator, 180 sq. ft.

2 Worthington 6½ x 8 Vacuum Pumps.

2 Spencer Turbine Co. Gas Boosters or Compressors, stainless steel, 30 HP motor, 650 CFM at 60 oz. pr.

2 Ingersoll Rand Type FS-538 Blowers, 4000 CFM at 3 lb. pr.

3 Ammonia Compressors—8 x 8, 7½ x 7½, 6 x 9.

3 Copper Beer Still Columns with condensers, etc., 18" dia., 24" dia., 30" dia.

6 Copper Bubble Cap Columns, 18" dia. to 48" dia.

6 Aluminum Columns, Bubble cap, etc.—24", 27" & 36" dia.

1 Steel Bubble Cap Column, 82 plates, 30" dia.

2 Copper Extraction Stills—48 GPH & 70 GPH.

3 Water Stills, 30 GPH & 250 GPH.

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— Prompt Shipment —

GLASS LINED TANKS — USED — 2000 gallon capacity. Welded construction—Fully insulated. Equipped with manhead. Suitable for milk, food products, lily white chemicals, solvents and fine lacquers.

TWO COMPARTMENT TANKS—USED—Hinged covers. 50" x 10' x 23" deep—2/16" Steel. 750 gallons. Suitable for cooking-mixing or storage.

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LURIA STEEL & TRADING CORP.
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MIXER—Day—Double Sigma Blade—2 Barrel Cap.

MIXER—Reade—1 Barrel Cap.—Bar Arm—Dough

MIXER—Reade—Ribbon Type—Steam Jacketed for 25# W.P. ½ Heavy Duty

KETTLES—From 40 Gallon to 100 Gallon Stainless Steel — In Stock — NEW AND USED

TANKS—Stainless Steel and Steel — All sizes to 3000 gallon

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FOR SALE

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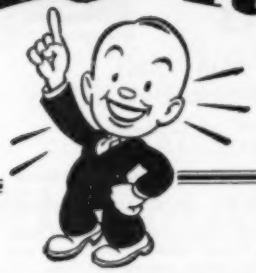

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1—8' x 12' ALL STAINLESS STEEL Feinc Rotary Continuous Vacuum Filter, string discharge, with blankets and STAINLESS STEEL trough, repulper, receivers, vacuum pump, motors, reducers, etc. Shop #387.

1—3' dia. x 1' Oliver Rotary Continuous Vacuum Filter, top feed, with vacuum receiver.

1—Zaremba Evaporator, single effect, all steel, vertical tubes, 566 ft.

1—Double effect Swenson Evaporator, each with 352 horizontal tubes, total h.s. 1344 sq. ft.

1—4' x 30' STAINLESS STEEL lined Rotary Dryer, with reducer and 10 H.P. motor.

2—32" x 32" Smith Vaile Wooden Filter Presses, corner feed, open delivery, 2 eye, with gear closing devices.

1—18" x 28" Bird Continuous Centrifugal, STAINLESS STEEL, copper housing, with 10 H.P. motor.

4—Swenson-Walker Jacketed Crystallizers in 10' sections, (1—70' lo. and 3—80' lo. each with pulley driven gear reducer and 10 H.P. A.C. motor). Units are 24" I. D. x 26" high with ⅜" thick steel plate and ¼" steel jackets, steel covers and ribbon agitators.

1—Bird Laughlin Continuous Centrifugal, screen type motor driven, 36" x 40", 25 H.P. motor, contact parts of stainless steel. All stainless steel contact parts.

2—Rotex Sifters, 40 x 84", deck #11 20 x 48"; also 4—No. 71 40 x 84" Roball ALL STAINLESS STEEL SIFTERS.

1—MIKRO Pulverizer #1 with 7½ H.P. motor.

2—Dorr 2-deck Washing Rake Classifiers, each 3' x 26'6" long and with 5 H.P. motor and reducer.

3—Quaker City Hammer Mills, Size M-20, each with 5 H.P. motor.

10—La Bour Centrifugal Pumps, #10W, #15W, 20 W. R-55 alloy.

9—Steel Mixing Tanks: 15 x 13', 11 x 7', 10 x 7', 5' x 4' with agitators, steam coils; 8' x 30' horizontal.

250 Ft. Approximately—SCREW CONVEYOR, 6", 12" steel encased, various lengths, motor drives. Also various Lengths of Redler Conveyor.

All Machines Are Direct Motor Driven, 3/60/440-220 Volt Motors, Most with Enclosed Gear Reducers

Immediate Delivery on Those Items in Stock

3—42" All Stainless Steel Centrifugals, Amer. T&M Co., each with S/S basket, curb, casing, shaft, unloader, and 40 H.P. variable speed Slip Ring 3/60/440 V. 1200 RPM motor with full controls. Suspended bottom discharge type. Now at Newark.

1—6' x 50' Louisville welded shell Rotary Steam Tube Dryer with two rows, 54 tubes. Also two 6' x 27' Davenport, Same Type.

2—5 Roll Raymond High Side Pulverizers.

1—8' x 12' Oliver Lead—Wood Vacuum Filter. Acid-resisting.

1—4' x 8' Kennedy Ball Mill, continuous UNUSED.

1—5'4" dia x 40' STAINLESS STEEL Rotary Dryer, Ruggles Coles.

3—Oliver Vacuum Filters, incl. 8 x 12', 11'6 x 14', 11'6 x 18'.

1—6' x 4' Flaker, chrome-plated m. d.

4—SWEETLAND FILTERS—No. 12 with 36 steel, bronze or Monel leaves; also #5.

2—ALUMINUM Sperry FILTER PRESS, 30" x 30", 1—24" x 24" Plate and Frame, 45 chambers.

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This equipment is excellent for use in the production of medicated candy, cough drops and candy containing antibiotics

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PACKAGE MACHINERY CO. CA2 BOX WRAPPERS (New 1946). With electric eye, wax application unit, tear tape attachment, continuous chain feed and heat-sealing units. Adjustable. Speed to 140 per minute.
TOWNSEND ROLL WRAPPERS WITH AUTOMATIC FEEDERS. Have automatic hoppers that assemble individual pieces, wraps them with glassine and with wax paper. Capacity—60 rolls per minute.
MINT ROLL WRAPPERS, COMPLETE WITH MOTORS AND HOPPERS.
BAKER PERKINS PLASTIC HARD CANDY TABLET FORMING MACHINES with 3-way cooling conveyor and sorter. Capacity—up to 2,000 pieces per minute.
MIKRO 4TH, 2TH, 1SH PULVERIZERS.
COLTON ROTARY TABLET PRESSES.
COLTON WET GRANULATOR.
STOKES DRUG MILLS.
DRY POWDER MIXERS.

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Inspection at Our NEW YORK SHOWROOMS and at our CHICAGO SHOWROOMS at 167 North May St.
THIS IS YOUR CHANCE OF A LIFETIME TO SECURE THIS MOST DESIRABLE EQUIPMENT AT REAL BARGAIN PRICES

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(DRY)
250 CFM—29.4" Hg
Single Stage
Ingersoll Rand Type 15
Vertical Water Cooled
—5 AVAILABLE—
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2 S.S. type 316 Pressure Filters, with 20 24" Dia. Leaves, Like New
Day 15 Gal. Jktd. Mixer, 2 cored Masticator Arms, with reducer & 5 HP motor
Day 5 Gal. Jktd. Vacuum Mixer, Sigma Blades, S.S., complete
Tumbling Barrel 5' x 5', type 347 S.S.
7 Shriver C.I. Filter Presses, 12" to 42"
Pfaudler 750 Gal. Glass Lined Jktd. & Agtd. Tank, with motor
B&J Rotary Cutters, #0, #2, #2½ with AC motors & knife sharpeners
Autoclave 3500 Gal., Jktd., & Agtd., with motor, also 2 & 50 Gal. Cap.

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PAINT MILLS—3 roll J. H. Day 16" x 40", water cooled.
FORK LIFT—Ross 19 hp. 7500# pneu tires.
FILTER PRESS—Shriver 42" pf. closed.
MILL—Raymond 0 with Fan & cyclone.
MILLS—Hardinge 5' x 22", 6' x 36", 8' x 22", w/motor.
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8—20,000 GAL. 10'6" x 31' Horiz.
74,000 & 228,000 GAL. Vert.
6—10,000 GAL. 10' x 17'2" Horiz.
4—15,000 GAL. 10'6" x 23'6" Horiz.

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FUSED SILICA PIPE FOR SALE

Unused Surplus—reduced price
60 lengths 8" x 75", open both ends,
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55 CYPRESS TANKS

Approximately 3200 gal. cap. each, 9' dia. by 8', with four 4"x6" molded end pieces, 15"x17" manhole, with iron inward swinging cover, eight ⅞" galvanized steel hoops, and patent tightening lug, four bell base screw jack floor stands, pitched interior, shellacked and painted exterior, like new, replacement cost today according to manufacturer $1000 each; we offer immediate delivery at considerably less than half of new, still erected and inspection invited at

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GELB MACHINERY

THE GELB GIRL MAY 1951

2—Blaw-Knox Jacketed Autoclaves with agitators, 300 and 500 gals.
3—Louisville Rotary Steam Tube Dryers, 6' x 25'.
1—Patterson Porcelain-lined Pebble Mill, Type D, 4½' dia. x 3' complete with 25 HP motor and drive.
1—Niagara Stainless Steel Filter 146 sq. ft.
1—Sperry 30" x 30" Cast Iron Recessed Type Filter Press, 50 chambers.

1—Tolhurst Stainless Steel Suspended type Centrifuge, 40" Perforated Basket.
1—Tolhurst Stainless Steel Suspended type Centrifuge, 40" Imperforated Basket.
1—Steel Jacketed Vacuum Kettle, 2400 gal.
1—Shriver 30"x30" Filter Press, 34 Chambers, closed delivery 4 eye washing type.
6—Cast Iron Jacketed Kettles, 210 to 600 gals.
1—Buflovac Shelf Dryer, single door 17 shelves.
1—Buflovac Single Door Vacuum Shelf Dryer, 5 shelves.
1—Kewanee 125 H. P. Boiler, 125 lbs. pressure.
3—International 200 H. P., 125 lbs. pressure Boilers.
1—Shriver Filter Press, 36"x36", closed-delivery, side-feed, 25 Chambers.
1—Sperry 30"x30" Recessed Type Filter, centre-feed, open-delivery, 42 Herculite covered Plates.
1—Sperry Aluminum Filter Press 18"x18", 5 Chambers.
3—Pfaudler Glass-Lined Jacketed Kettles, 300 gals. cap.
14—Pfaudler Glass-Lined Jacketed Kettles, 330 gals. cap.
3—Pfaudler Glass-Lined Jacketed Kettles, 360 gals. cap.
3—Pfaudler Glass-Lined Jacketed Kettles, 460 gals. cap.
1—Copper Jacketed Kettle, 6'x5' with agitator.
2—Pfaudler Glass-Lined Jacketed Reactors 1,700 gals. cap.
5—Rubber-Lined Storage Tanks 350 & 250 gals. cap.
5—Stainless Steel Storage Tanks 55, 150, 221 gals. cap.
1—Stainless Steel Clad Storage Tank 5,100 gals. cap.
3—High Chrome Storage Tanks 3,000 & 6,000 gals. cap.
2—Black & Clawson Double Drum Dryers 28"x5'.
1—Ruggles Coles Direct Fired Kiln 7½'x80'.
1—Banbury Mixer #1 with 50 Hp motor.
4—Baker Perkins Jacketed Vacuum Type Double Arm Mixers with Motors & Drives, 100 gals. cap.
1—Cavagnaro Vacuum Type Double Arm Mixers with Motor & Drive, 150 gals. cap., Stainless Steel.
2—Cavagnaro Steel Jacketed Mixers, Chromium Plated, Interior double arm, flattail blades, 100 gals., cap., vacuum type with 40 HP Motors & Drives.
3—J. H. Day Double Arm Jacketed Mixers, 50 gals. cap., sigma blades.
1—Baker Perkins Laboratory Mixer, size #6.
1—Baker Perkins Double Arm Jacketed Mixer, 200 gals. cap., sigma blades.
3—Baker Perkins Double Arm Mixers, 200 gals. cap., sigma blades.
1—Patterson 5,000 gals. cap. Turbo Mixer "Unused".
2—J. H. Day Mogul Type Mixers, 2½ & 5 gals. cap.
5—Simpson #0 Intensive Mixers, "Unused".
1—Simpson #1 Mixer.
2—Louisville Rotary Steam Tube Dryers, 6'x50'.
3—Buflovak Flakers 5'x12'.
2—Buflovak Vacuum Drum Dryers, 24"x28".
2—Buflovak Vacuum Drum Dryers, 5'10"x10".
1—Day Pony Mixer 15 gals. cap.
1—Gomco Copper Conical Blender, 3½ cu. ft.
4—Sweetland Filters, 10, 7, 2, 1 & Laboratory Size.
3—Vallez Filters, #2E, 2B & 3.
10—Alsop Bronze & Brass Filters, Model #PAK 12-4.
3—Oliver Rotary Filters, 6'x10', 5'x12', & 3'x6'.
19—Sharples Super Precipitite Centrifuges #6.
1—Sharples Super Pressurite Centrifuge, Stainless Steel Bowl, Model #16V.
1—Podbielniak Stainless Steel Centrifugal Extractor Model #5000.
2—Mikro Pulverizers #1SH.
1—Royle #1 Perforated Extruder, with heating unit.

1—J. P. Devine Vacuum, Jacketed Kettle, 3000 gal.
5—Copper mixing Tanks, 3100 gals.
2—Copper Columns, 36" x 80'.
2—Sperry 18" x 18" — P&F — closed deliv. filter presses; tin plated—20 chambers.
1—Shriver Jacketed Plate & Frame, Filter Press, 36" x 36", 48' chambers.

1—American Locomotive Stainless Steel Heat Exchanger, Model Twin Double Pipe, Size 3½x2? x24'.
4—Steel Heat Exchangers, 800 sq. ft. each.
1—Allis Chalmers Tube Mill 5'8"x10', Silex-Lined.
3—Hardinge Conical Ball Mills 8'x30', 8'x22', 6'x22'.
1—Abbe Engineering Silex-Lined Pebble Mill, 6'x12'.
1—Abbe Engineering Buhrstone-Lined Ball Mill, 5'x4'.
1—Ball Mill, Stone-Lined, 7'x9'.
1—Blaw-Knox Jacketed Autoclave 3'x4'2" with agitator.
3—Hershey Rotary Dryers, 5' x 22' and 6' x 24'.
1—Stainless Steel Jacketed Kettle, 320 gal.
1—High Pressure Steel Autoclave, 900 psi., 3'x4', with agitator and motor reducer.
1—J. H. Day #71 Re-Ball Jacketed Stainless Steel Oyrating Screen Cooler.
3—Orville Simpson #41, Rotex Screens.
2—Wilson Pulsafeeders, Model #DELBO.

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VAPORIZING SYSTEM • VAPOR PRESSURE REDUCING STATION
UNLOADING COMPRESSOR • VAPOR-AIR MIXING & CONTROL SYSTEM*

*Includes Colormixer and Askania Ratio-Regulator, Pressure Difference Regulator and Motor Operated Adjuster.

THIS PLANT CAN BE PURCHASED COMPLETE, OR AS INDIVIDUAL UNITS SEPARATELY

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Conical, copper, 20", 2.7 cu. ft.

CENTRIFUGES
Bird, 36"x50" cont., rubber covered, SS.
24" Bird, cont., type CH, series 200, steel.
60" AT&M, SS type 316.

FILTERS
Oliver, 8'x10', 250 sq. ft., wood & steel.
Sweetland, size 12, steel, 72 leaves.

FLAKERS
48"x40", Buflovak, steel (3).

PRESSURE VESSELS
3,500 gal. 5'x24'x3/4" 225 PSI (5).
8,200 gal. 6'x40'x2" 225 PSI (2).
10,000 gal. 8'x27'x1" 225 PSI (2).

KILNS—COOLERS—DRYERS
±502-20 Rota Louvre.
3'x48'x3/8" shell.
4'6"x40' Traylor.
6'x14'x9/16" Struthers-Wells (2 NEW).

STORAGE TANKS
350 gal. 3'x6'6"x1/4".
1,150 gal. 54"x9'x5/16", 1/2 heads (2).
1,600 gal. 8'x7'x3/16" cone bottom (2).
2,100 gal. 9'x6'6"x3/16" cone bottom (2).
2,300 gal. 5'x17'x1/4" SS.
3,000 gal. 5'x21'x1/4", type 430 SS.
6,500 gal. 76"x27'10" TANK CAR TANKS (30).
9,600 gal. 11'x13'9"x3/8" (NEW).
13,500 gal. 10'x21'6"x1".
15,300 gal. 9'x32'x5/16".
16,200 gal. 10'6"x25'x1/4".

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Haveg, 36"x11'.
24"x94" rubber lined.
20"x63" steel.
72"x29'8" SS Bubble Cap.
5'x43' steel Bubble Cap.
6'x44', Scrubber, steel.

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COMPRESSORS—40 & 150 CFM.
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Specials

1—Stainless Steel 18" Bubble Cap Column.
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1—Sperry 42" Wood Plate & Frame Filter Press, 57 ch's., Hyd. Closure.
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1—Flaker 4' x 9'—Motor Drive.
1—Stainless Steel 75 gal. Jack & Ag. Autoclave, 500# int. press., 125# Jack.
1—Premier Type U-4 S.S. Mill, 20 H.P. 3 Ph. Motor.
1—W. & P. 100 gal. Stainless Steel Mixer.

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54" x 45' Christie Rotary Dryer (indirect).
Heat Exchanger, 58 s.s. plates.
100 gal. S.S. Clad Jkt. Kettles, 30" x 52".
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350 gal. S.S. Tank with s.s coil.
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28" x 60" to 32" x 120" Double Drum Dryers.
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75 to 1500 gal. Homogenizers or Viscolizers.
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SCREW CONVEYOR: 12" x 22 ft. with center bearing, 87 RPM, capacity 30 TPH.
FANS: 2—Buffalo Forge Co. No. 12 Turbo Conoidal Fans, 6" shaft, 50 H.P., A.C. motors.
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BRIQUETTING PRESS: Capacity 18 tons per hour, 33" dia. rolls.
TANKS: 6—Steel Tanks, vertical, self-supporting, convex top, cone bottom, welded type, 8 ft. high, 6 ft. dia. NEW. Drawing available.
DRYERS & KILNS: 5 ft. x 40 ft. up to 10 ft. x 90 ft., single and double shell.
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XB-10—70" x 35' Indirect Heat Ruggles-Coles.
Direct Heat: 4' x 20', 4' x 45', 4½' x 60', 5' x 50', 6 x 35, 6'-6" x 60', 7' x 50', 8' x 70' & 10' x 90'.

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15" Three Stage Wetherill Type Magnetic Separator
20", 6', 10' & 16' Mechanical Air Separators
2—40" Centrifugal Extractors
6' x 45' Hardinge Air Swept Ball Mill
5' x 22' Hardinge Ball Mill, Screw feed
#0 & #1 Raymond Automatic Pulverizer
4 x 45, 6 x 60 & 9 x 170' Rotary Kilns
2—8' x 12' Oliver Continuous Filters
6—11'6 x 14' Oliver Continuous Filters
2—9" x 8" Durco Centrapos Centrifugal Pumps
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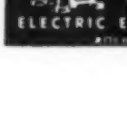

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Pumps: 52 GPM, stain. steel, reciprocating.
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Dryer: Atmospheric Stokes, 4x6' single drum.
Centrifugal: Fletcher 12" perf. stain. steel.
Drum Dryer: Buflovak 5' x 12'.
Autoclave: 10 gal. Buflovak, cast iron.
Ball Mill: Abbe 50 gal. jacketed.
Mixer: Struthers-Wells 4x4' jack., closed.
Powder Mixers: 100 to 2000 lb. capacities.
Centrifugal: Rochester 30" copper basket.
Screens: Rotex, Robell—var. sizes.
Colloid Mills: Premier, Charlotte, Eppenbach.
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Kettle: 60 gal. stain. steel jack. agitated.
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NEW Stainless steel Jacketed Kettles from 50 gal. to 500 Gal. ready to ship on the day we receive your order.
500 Gal. Stainless Jacketed Reactor; 6' dia. x 30" in straight side with dished heads.
Stainless sprayed double arm Vacuum type MIXER; 5 gal. double arm; geared both ends.
Stainless Drying or Flaking Rolls from 32"x50" to 80"x120".
2 Stainless Spray Dryers; 8'x15' and 18'x52' with accessories.
READCO Stainless double arm Mixer; 140 gal. capacity
Ball Jewell Stainless Rotary Cutter No. 1½ with 30 HP motor.
Langenskamp Model B EZ Adjust Pulper in Stainless
Swenson Stainless Continuous Evaporator with Barometric Leg and Condenser.
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2 Hormanson Stainless Filters: pressure type; 24"x41"; like new.
Oliver Stainless Rotary Vacuum Filter; 6'x3'.
Pfaudler 500 Gal. Stainless Tank with agitator and cover.
Stainless Saw Tooth Crusher with 2 H.P. motor.
Sharples Super Centrifuge with stainless steel bowl; clarifier, separator type with 3 H.P. motor; bowl speed 13000 RPM.
NEW STAINLESS FILLERS of the Vacuum and Syphon type.
SPECIAL: New Stainless Tanks fabricated to your specifications on short delivery.

Stainless 500 Gal. Reactor; welded; jacketed.
Stainless Pressure Vessel 300 gal. 41"x5'.
Mojonnier Copper Vac. Pan; with Calandria; 6'x16'.
Perfect Sphere 76" diameter Heavy Copper Vac. Pan with Dephlegmator.
2 Haveg Reactors: 225 gal.; 37½"x33½" and 250 gal. 45"x34".
Dopp Cast Iron Jacketed Kettle; dished bolted top; 48"x 60".
Zahm & Nagel Continuous Concentrator; for foods and pharmaceuticals; 2500 lbs. of water per hour evaporated.

Pfaudler Steel Jacketed 500 Gal. Kettle; manhole type.
Allberger Karbate Hydrochloric Acid Recovery system with Scrubbing Tower capacity; 40 tons per day.
3 Globe Rotary Kiers 14' Diameter; ⅝" plate thickness; with 15 H.P. motors.
1 Stainless 250 Gal. Reactor; jacketed also good for vacuum with agitator.
Struthers Wells Closed Steel Reactor; 400 gal. 4'x5' with double motion agitator and 5 H.P. motor with gear reduction.
Pfaudler Glass Lined Reactor; 36"x32" with fully dished heads; 75 gal. capacity; jacketed 75#.

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Vacuum - Transfer - Circulating

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1 Day 150 Gal. Brighton Mixer.
5 Pebble Mills 40 to 500 Gal.
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9" by 25"—12" by 26"—16" by 42".
1 Eppenbach Homo-Mixer.
1 Motor driven portable belt conveyor.
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1—Buffalo Vac Drum Dryer 24x20". Also Rotary Vac. Dryers.
12—Steam, Gas & Electric Dryers. Tray, Truck & Conveyor Types.
6—Rotary Dryers, Direct & Indirect. Also Jacketed & Steam Tube.
New Rotary Dryers, Kilns & Coolers built to order.

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12—Sharples Centrifuges #5A Stainless. Also #6.
3—De Laval Multiple Clarifiers #200, 300 & 301.

FILTERS

10—Sperry & Shriver 12", 18", 24", 30", 32", 36" & 42" Iron & Wood Filter Presses.
1—12" Bronze Filter Press. Extra Iron Plates & Frames, 10" & 48".
Sweetland Fainc, Oliver & Valley Rotary Vac. Filters.

KETTLES & TANKS

1—Doop 1000 gal. closed Agit. Jack. Kettle. Also smaller sizes.
2—Struthers-Wells 10 gal. Jack. Agit. Autoclaves.
1—250 gal. Lead Lined Kettle.
6—Jacketed Kettles 50 to 1000 gals.
25—New Stainless Steel Tanks 50 to 1000 gals.
15—Stainless, Alum., copper, Glass & Lead Lined Kettles & Tanks.
Impregnating Units, Lab. or Pilot Plant & Up.
Leominster #0 Rotary Cutter.

PULVERIZERS & MILLS

1—#00 Raymond Mill 30 HP., complete.
3—#1 & #0000 Raymond Mills.
6—Hammer Mills & Pulverizers 3 to 50 H.P.
1—Schutz-O'Neill 20" Pulverizer. Also #1.
1—Sturtevant 30" Rock Emory Mill.
1—Robinson 22" Attrition Mill.
1—Robinson No. 10 Saw Tooth Crusher.
1—Double Roll Crusher 10" dia. x 14" face.
1—Lehman 4 Roll W. C. 12" x 36" Steel Mill.
3—Lehman & Kent 3 Roll Steel Mills, 8" x 14", 8" x 22", 9" x 32", 12" x 30" & 18" x 40".
1—9" x 24", 3 Pair High, Steel Roller Mill.
3—Hoschin 18" x 36", 4 Roll Granite Stone Mills.
3—Abbe Pebble Mills 6' x 6', 3' x 3½' & 2' x 2½'.
3—Abbe Jar Mills Lab to 13 gal. sizes.
Rotary Cutters Mikro Pulverizer, Fitzpatrick Comminuting Mills, Etc.

MIXERS—ALL TYPES

7—Baker-Perkins heavy duty double arm Jack. mixers, 200 & 9 gals.
12—Horiz. Mixers 35 to 200 gals., single & double arm.
6—Pony or Paste Mixers, 8, 15 & 40 gals.
1—Century 2 HP, 4 speed Vert. Mixer.
6—Lead & Paste Mixers 50 to 150 gals.
4—Simpson Intensive Mixers #0 to 3-½.
1—Master Drum Type Blender 1000#.
10—Dry Spiral Mixers 50 to 2000#.
12—Portable Elec. Liquid Mixers ½ to 3 HP.

SCREENS & SIFTERS

2—Tyler #3B Jr. Hummer Screens, 20"x30".
1—Rotex Sifter 20"x84", 4 Surfaces.
3—Gyratory suspended type Sifters 28" dia. & 24"x32".

MISC. & SPECIALS

Stokes R preform Tablet Machine 2¼" dia.
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4—French Oil 400 Ton Linseed & Cottonseed Hydr. Presses.
6—French Oil Motor Driven Expellers.
New 6" x 12" Lab Mixing Mills & Calenders.
4—Farrel 15" x 36", 18" x 48", 10" x 48" & up to 22" x 60". 2 Roll Mixing Mills.
1—Rubber & Plastic Extruders 1½" to 6".
2—Stokes 2E Paste Fillers up to 5 gal.
1—Marco #200 Stainless Steel Homogenizer.
1—Stokes & Smith 4 Day Powder Fillers.
1—Filling Machines, Liquid, Paste & Powder.
1—Stokes & Colton Rotary & Single Punch Tablet Machines, ½" to 3".
2—Revolving Pans 30" & 36".
10—Stokes, Vert. High Vac. Pumps.
2—Worthington 12" x 12" & 12" Vac. Pumps.
6—Devine & Buffalo Vac. Pumps, Steam, Belt & Motor Driven.
Houchin 5000# Soap Crusher & Smaller sizes.
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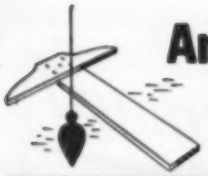

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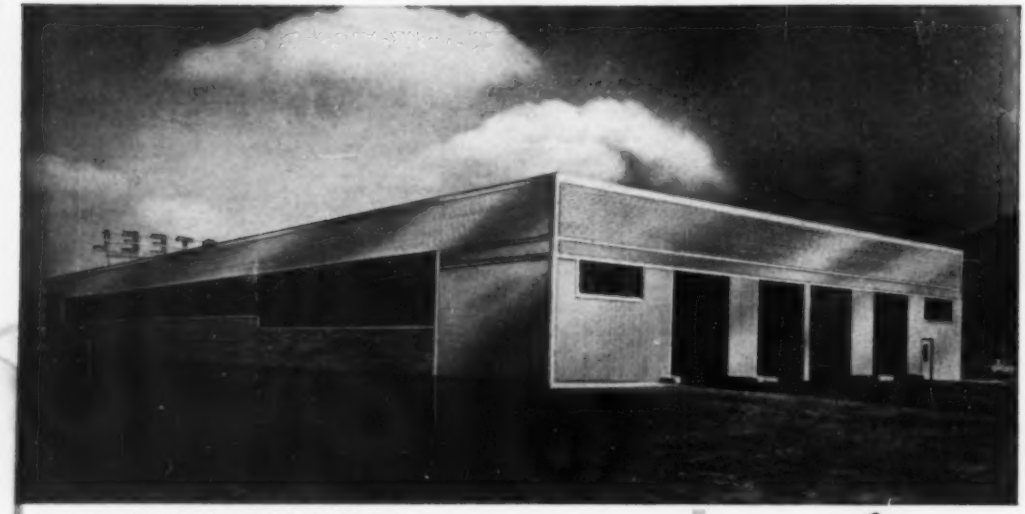

New warehouse—Ward Steel Co., North Cambridge, Mass.

When the Ward Steel Company of North Cambridge, Mass., undertook to build the most modern steel warehouse in New England, they called on Waghorne-Brown as designers and engineers. Waghorne-Brown specified rustproof, corrosion-resistant Reynolds *Lifetime* Aluminum Industrial Corrugated for siding. Their reasons were: appearance, long life, low initial cost and low maintenance (no painting)... plus great strength combined with light weight that saves money on framing (see specifications).

Aluminum's radiant heat reflectivity was another deciding factor. On walls or roof, it reduces inside summer temperatures and cuts winter fuel bills. An interesting detail in this building is the contrasting horizontal and vertical application, with aluminum corners and edging. For technical assistance and application details, call any Reynolds Office. Literature on request.

• Offices in principal cities... check your classified phone book for our Building Products listing, or write Reynolds Metals Company, Building Products Division, 2005 South Ninth St., Louisville 1, Ky.

Aluminum is required for planes and other military needs. Reynolds *Lifetime* Aluminum Industrial Corrugated is still produced, but the total supply is necessarily reduced. DO-rated orders receive priority handling.

Specifications for Reynolds *Lifetime* Aluminum Industrial Corrugated:

Thickness .032"
Corrugations 7/8" deep, 2-2/3" crown to crown
Uniform load support (roof) 80 p.s.f. on 4' purlin spacing
Uniform wind load capacity (siding) 20 p.s.f. on girt spacings up to 7'9"
Roofing width 35", coverage 32"
Siding width 33-3/4", coverage 32"
Lengths 5', 6', 7', 8', 9', 10', 11', 12'

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TO MAKE IT HANDY

Products and literature in this issue are listed on these pages. There are two indexes. (1) editorial items on new equipment, new products, new literature; (2) products advertised. The index of advertisers is on the proceeding page.

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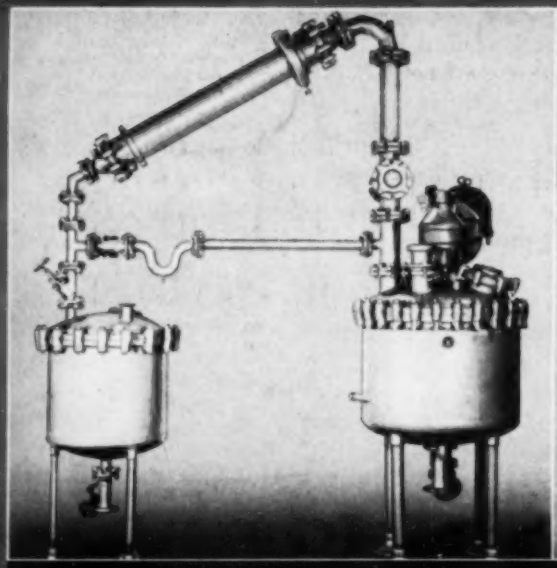

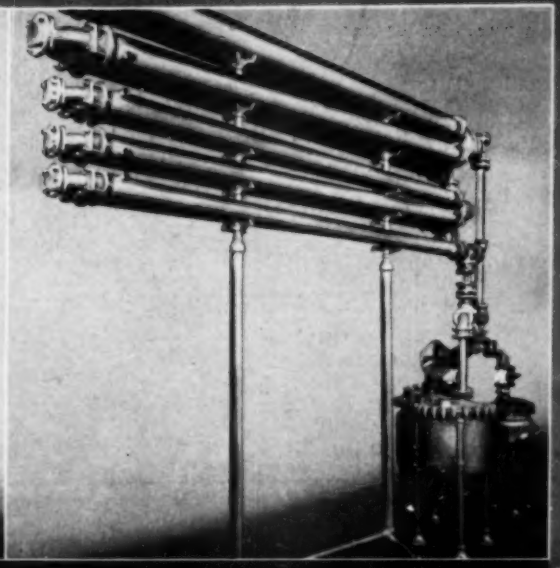

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